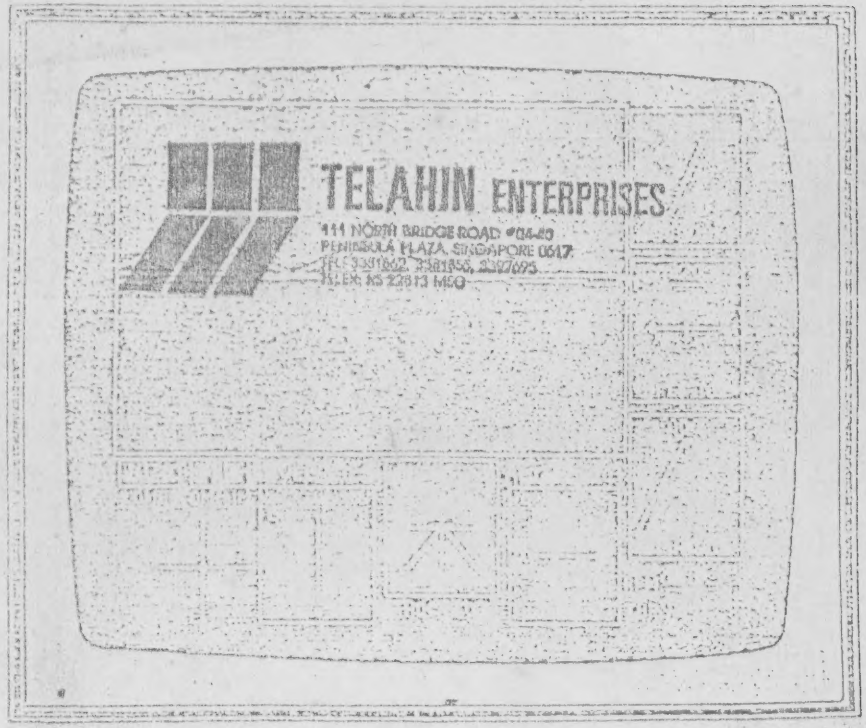
FLIGHT SIM 2™

AIRPLANE SIMULATOR

For the Apple II Computer



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AIRSIM-3
Airplane Simulator
for the
Apple II Computer

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October 1983

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TABLE 1. NAVIGATIONAL AIDS

(For use in AIRSIM-3 only)

LOC/VOR	Freq'cy	Latitude (Deg)	Latitude (Min)	Longitude (Deg)	Longitude (Min)
Localizers					
1 ILS Training Field RWY 27	111.1	35	59.15	119	47.92
2 San Diego RWY 28R	111.7	32	48.80	117	7.75
3 Long Beach RWY 30	110.3	33	48.80	118	8.50
4 Los Angeles RWY 6R	111.7	33	57.45	118	25.90
5 Los Angeles RWY 24L	108.5	33	57.58	118	24.14
6 Santa Barbara RWY 7	110.3	34	25.70	119	50.75
7 Monterey RWY 10	110.1	36	35.63	121	51.60
8 San Francisco RWY 28L	109.5	37	36.15	122	21.85
VOR's					
9 Airsim	114.9	36	6.85	119	47.70
10 Big Sur	114.0	36	10.60	121	38.30
11 Fellows	117.5	35	5.50	119	51.85
12 Fillmore	112.5	34	21.30	118	57.00
13 Gaviota	116.5	34	31.80	120	5.50
14 Julian	114.0	33	8.20	116	35.20
15 Los Angeles	113.6	33	55.80	118	26.00
16 Mission Bay	117.8	32	46.80	117	13.50
17 Oakland	116.8	37	43.70	122	13.30
18 Paso Robles	114.3	35	40.20	120	37.30
19 Pomona	110.4	34	4.60	117	47.30
20 Salinas	117.3	36	40.05	121	36.10
21 San Francisco	115.8	37	37.05	122	22.00
22 San Luis Obispo	112.4	35	15.20	120	45.40
23 Santa Barbara	114.0	34	30.05	119	46.30
24 Santa Monica	110.8	34	0.33	118	27.20
25 Sausalito	116.2	37	51.00	122	31.20
26 Seal Beach	115.7	33	47.20	118	3.00
27 Stockton	116.0	37	54.60	121	10.20
28 Ventura	108.2	34	6.80	119	2.90
LOM/NDB					
Outer Marker Beacons					
1 ILS Training Field RWY 27	388	35	57.74	119	41.87
2 San Diego RWY 28R	210	32	46.48	117	2.18
3 Long Beach RWY 30	233	33	45.57	118	3.87
4 Los Angeles RWY 24L	278	33	58.13	118	16.94
5 Monterey RWY 10	385	36	37.45	121	56.53
6 San Francisco RWY 28L	379	37	33.67	122	15.35
NDB's					
7 Bodega Head	325	38	18.70	123	3.20
8 Chualar	263	36	29.70	121	28.30
9 Escondito	374	33	9.70	117	5.40
10 Farallon Islands	314	37	41.90	123	0.40
11 Fort Ord	236	36	38.70	121	40.70
12 Pajar	327	36	54.40	121	48.30
13 Swan Lake	397	33	58.70	117	33.00
14 Pigeon Point	286	37	10.90	122	23.80
15 Point Arena	320	38	57.30	123	43.90
16 Point Sur	322	36	18.70	121	55.80
17 San Clemente Island	350	33	1.00	118	35.10
18 San Luis Obispo	288	35	9.80	120	45.25

1. INTRODUCTION

AIRSIM-3 is our third flight simulator, the first two being AIRSIM-1 and SPITFIRE SIMULATOR. AIRSIM-3 is similar to AIRSIM-1; it simulates a high-performance privately owned light airplane. However, AIRSIM-3 is not just a rewrite of AIRSIM-1, but rather a completely new flight simulator with many improvements and new features.

When we introduced AIRSIM-1 in 1981, we were surprised to discover how many of our customers are pilots. Many of them contacted us subsequently, and offered suggestions for features which they would like to see in flight simulators for personal computers. Many expressed the belief that personal-computer flight simulators could play a useful role both in pilot training and in helping even experienced pilots maintain instrument-flying proficiency. We decided to develop a new flight simulator, AIRSIM-3, to meet the needs expressed to us by pilots. We've provided the basic flight instrumentation found in airplanes plus all the navigational instrumentation required for instrument-flying practice. Several pilots expressed a desire for a facility permitting them to set up custom landing-approach situations of their own specifications, and we have done that; we've provided a "Your-Approach" mode which permits the user to specify wind conditions, runway location (with runway scenery), and the locations of the navigational aids. We've also provided a "Move-with-Joystick" mode which helps the user to explore the various navigational aids and to develop quickly a good intuitive feeling for how the navigational instruments work. We've made significant improvements in the handling characteristics of the simulation.

AIRSIM-3 is a large program, almost completely filling 48K bytes of RAM. It was a big development project, and we're pleased with the results. We believe that both pilots and nonpilot flying enthusiasts will find AIRSIM-3 to be an enjoyable and educational means for experiencing many of the aspects of airplane flight.

What, you may ask, happened to AIRSIM-2? Well, there was and is an AIRSIM-2. That was the in-house name for our SPITFIRE SIMULATOR, a flight simulator in which you fly a 360 mph Spitfire fighter of World War II and pursue three-dimensional target aircraft such as Me 109's.

Our primary objective in developing AIRSIM-3 was to provide a simulation of airplane behavior that is as realistic as possible within the constraints imposed by the hardware of the standard Apple II, II+, IIe computers. Some compromises did have to be made, but we are pleased with what we were able to achieve within these constraints. The most fundamental of these compromises concerns the airplane controls. We had two paddle-control inputs available for use with either paddles or a joystick, and had to choose which of the three airplane controls -- elevator, aileron, and rudder -- to associate with these two paddle-control inputs. The rudder is important on the ground, while the aileron is important in the air. In the air, an airplane can be flown quite well without any rudder control at all. Therefore, we decided to use one paddle-control input for controlling the rudder when on the ground, and the ailerons when in the air. We used the other paddle control for the elevator both on the ground and in the air. We've provided two levels of control sensitivity for the aileron and elevator inputs. There is also optional coupling between the rudder and the ailerons, providing combined aileron and rudder action if desired. The resulting airplane simulation flies quite well, and is even aerobatic. It performs nice rolls, loops, stalls, wing overs, and even Immelmann turns!

We've provided you with computer scenery which you can see through the cockpit windows. The scenery includes a horizon, and the California coastline from north of San Francisco to just south of San Diego. There is in addition a fictitious "Home" scene located in the central valley, northwest of Bakersfield. This Home scene is provided as an aid for beginning pilots, and contains three separate runways for practice and recreational flying.

The scenery includes 6 airports, in addition to the runways of the Home scene, located from San Francisco to San Diego. The runways for these 6 airports are all accurate representations of corresponding real airports. Each of these airports is equipped for instrument approaches.

There are in addition many navigational aids distributed throughout the region covered by the scenery. Thus, it is possible to take off from any airport and fly with the aid of navigational instruments to another airport, and to land at any airport. Flying long distances can be tedious, so we've provided two commands which allow you to transport the airplane quickly to any point you want. That is real computer magic!

AIRSIM-3 includes a radar, as did AIRSIM-1 and SPITFIRE SIMULATOR, which allows you to see a map-like representation of the ground below you. This radar also shows the locations of the navigational aids to which the navigational instruments have been tuned.

You'll be able to fly AIRSIM-3 even if you've never flown an airplane or another flight simulator before, because we'll give you flying lessons. We've even included a special training field at "Home" to help you learn how to land, the most important and perhaps most difficult maneuver to master. You'll probably have lots of crashes learning how to fly. That's all right. We crash lots of times too. One of the nifty things about a computer airplane is that, if you crash, you can recover just by pressing the right key -- in this case CTRL-C. Then you are all set to try again!

Before you go flying with AIRSIM-3, there are a few things we would like to say which we believe you'll find helpful, especially if this is your first experience with a flight simulator. PLEASE DO NOT OVERCONTROL THE AIRPLANE! The biggest problem people encounter initially is a tendency to overcontrol the airplane. Beginning AIRSIM-3 pilots should use only very small control inputs. Make a small control movement, and then hold it constant to see how the airplane responds. We find it helpful to adopt the point of view that airplanes know a lot more about flying than we do, and that the best way to fly an airplane is to let it fly itself for the most part. AIRSIM-3 can fly itself very nicely. You can make AIRSIM-3 perform aerobatic wonders, but you must first develop an intuitive feeling for how the airplane will respond to control inputs. That requires experience. Be patient and your patience will be amply rewarded.

Consider the following two factors when flying AIRSIM-3. First, there are inertia effects to consider. It takes time for an airplane to respond to control inputs, more time than an automobile takes to respond to a turn of the steering wheel. AIRSIM-3 simulates these inertia effects realistically. Secondly, AIRSIM-3 is doing a tremendous number of calculations for each new frame it displays. AIRSIM-3 is all in machine code, but these calculations nonetheless require between 1/2 second and 1 second for each frame displayed. This introduces another time delay to which you will have to learn to accommodate. You can master this time delay, but you may have to practice flying for some time to do it.

AIRSIM-1, because of its realistic flight characteristics, has been selected by a number of organizations for use in research on the effects of age and drugs on pilots. These organizations are using a special version of AIRSIM-1 which stores flight data on a 16K RAM card in Slot 0 in the Apple. This can also be done with AIRSIM-3. Persons interested in doing this can contact Mind Systems Corporation for additional information.

If you are fortunate enough to own a Mockingboard, you can have engine sound and a nice wheel-chirp sound when you land. AIRSIM-3 supports the Mockingboard Sound II and Sound/Speech I boards. If you have one of them, all you have to do is turn on the speaker for the board and you'll have their sounds.

Now it is time to go flying. Try to remember to relax and enjoy yourself at all times. We hope that you will find AIRSIM-3 to be a pleasant and informative way to experience the many challenges and joys of airplane flight and navigation.

We wish to express our appreciation to the many flying enthusiasts who have so kindly contacted us with helpful comments and suggestions. We hope that they will find in AIRSIM-3 that we have responded positively.

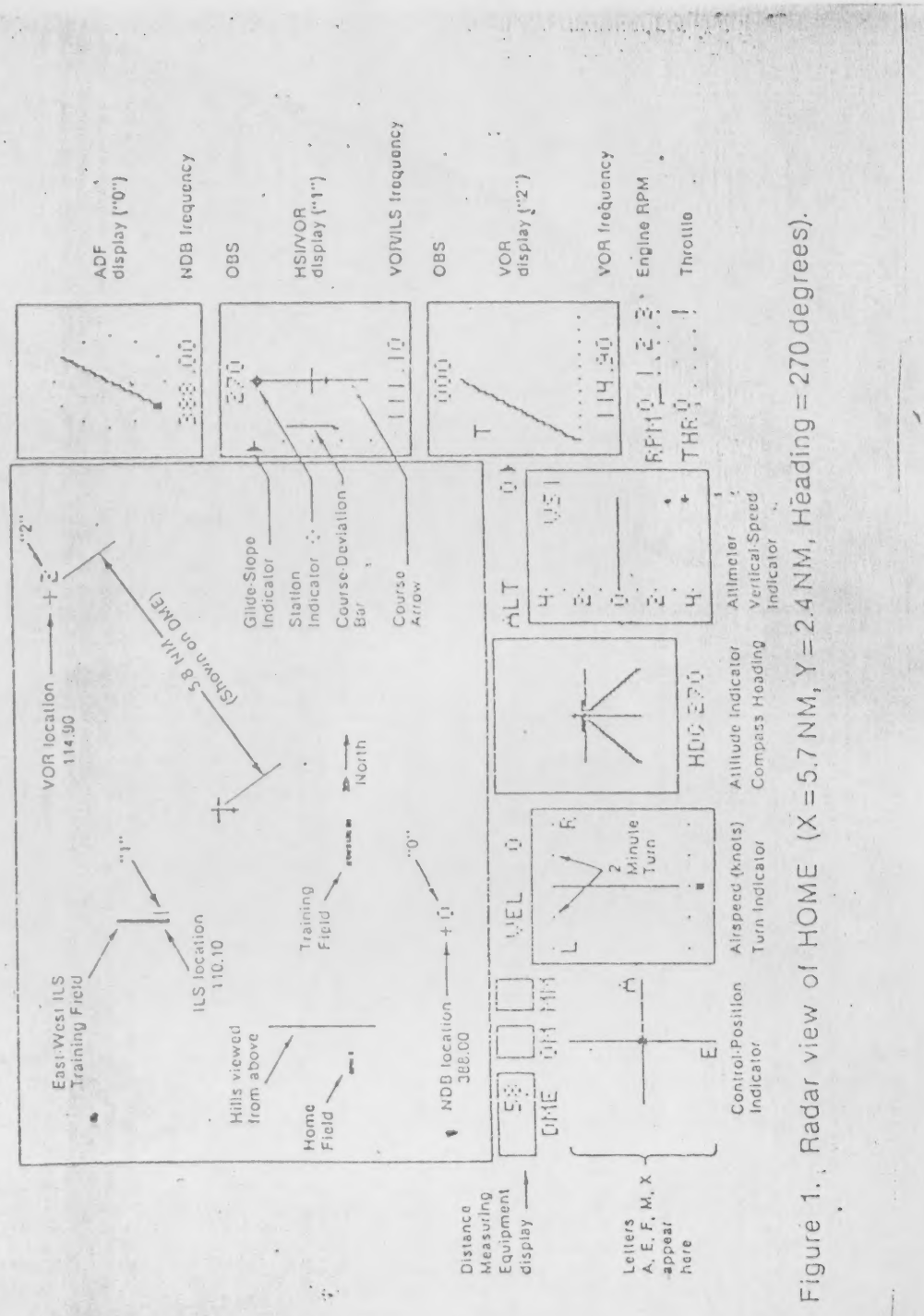

Figure 1. Radar view of HOME (X = 5.7 NM, Y = 2.4 NM, Heading = 270 degrees).

2. PROCEDURES, INSTRUMENTATION, AND CONTROLS

In this section we'll briefly outline how you use AIRSIM-3. We'll describe the hardware required, how to run the program, possible causes for problems, the instrumentation, and the controls for the simulation. The instrumentation and controls are illustrated extensively in the subsequent sections. For convenience, a list of commands is on the last page of this manual.

Hardware Required

You'll need an Apple II, II +, or IIe with 48K of RAM, one disk drive (DOS 3.3) and game paddles or a joystick. We prefer a self-centering joystick. Also required is Applesoft in ROM, or its equivalent in RAM if you are using a RAM card in slot 0 without the Applesoft ROM on the main board. AIRSIM-3 is all in machine code, but uses some subroutines in the Applesoft ROM/RAM space.

Running the Program

To run AIRSIM-3, insert the AIRSIM-3 disk in disk-drive No. 1, and boot the disk (PR#6 or 6 CTRL-P). You will hear the usual clattering noise while the disk drive looks for track 0, and then, very shortly, should see a title page with a copyright statement. The disk drive will clatter again, and start reading the AIRSIM-3 program. After about 20 seconds the disk should stop, and you should see a second title page that says "CENTER CONTROLS AND PRESS ANY KEY". This refers to the two game paddles or the joystick. If using game paddles, position each paddle so that there is approximately equal paddle motion in either direction. You'll want to mark these paddle positions in some way. We use arrow-head shapes cut from removable gummed labels. If using a joystick, this is an opportunity to adjust your trim settings. When ready, press any key, and the computer will record these reference positions as the zero-input control positions. You should then see the instrumentation and scenery shown on the front cover of the manual. A detailed description of how to proceed from there is presented in CHAPTER 3, A FIRST FLYING LESSON.

Possible Problems

It is exceedingly unlikely that AIRSIM-3 has loaded incorrectly if it displays any scenery. If you have any difficulty getting the program to run, the most likely cause is a problem with the paddles or joystick. Bent pins or improper insertion of the 16-pin game-control connector are common sources of difficulty. The following simple BASIC program is useful for checking the paddles or joystick:

```
10 PRINT PDL(0),PDL(1)
20 GO TO 10
30 END
```

If you RUN this program, you should see two streams of numbers which will vary smoothly between 0 and 255. The left-hand stream should vary as you move Paddle No. 0, and the right-hand stream should vary as you move Paddle No. 1. With your paddles or joystick centered, you should have readings near 128 for equal control effectiveness to either side of the central position. Erratic readings indicate paddle or joystick problems. In the event you encounter problems you can't resolve, contact us. We're always willing to help.

Instrumentation

The instrumentation is shown in Figure 1, which shows also a display obtained by pressing the R key for the radar display (described below) after the disk was booted. This instrumentation is as follows:

DME

: Distance Measuring Equipment. Shows the distance in nautical miles from the airplane to the VOR selected for the lower (secondary) VOR display ("2" in Fig. 1). The position of this VOR is shown by the "2" in the radar display. Its use is described in Chapter 6, INSTRUMENT FLYING.

OM

: Outer Marker indicator. When the plane is over the Outer Marker, a 400 Hz tone is emitted and an "X" is displayed in the OM box. The use of the outer marker is described in Chapter 6, INSTRUMENT FLYING.

MM

: Middle Marker indicator. When the plane is over the Middle Marker, a 1300 Hz tone is emitted and an "X" is displayed in the MM box. The use of the middle marker is discussed in Chapter 6, INSTRUMENT FLYING.

Control-Position Indicator

: Shows the position of the elevator-aileron/rudder controls via a small cursor. Up elevator moves the cursor towards the "E" and right aileron/rudder moves the cursor towards the "A".

VEL

: Airplane airspeed in Knots.

Turn and Bank Indicator

: The turn indicator shows the turn rate to the left (L) or to the right (R). This instrument is calibrated to show the turn rate for 2-minute turns when on instruments with no scenery (IFR mode or I key). The ball-bank indicator shows whether the airplane is side slipping to the left or to the right. This simulation does not have a separate rudder control in the air, so it may not be possible to center this ball.

Attitude Indicator

Indicates whether the plane is nose high or nose low, and whether the wings are banked relative to the horizon. The use of this instrument is described in Chapter 4, ADVANCED FLYING TECHNIQUES.

HDG

Magnetic-compass heading in degrees.

ALT

Altitude above sea level in feet. The thousands units are separated from the hundreds. A small triangle to the immediate right indicates by its orientation whether the altitude is increasing or decreasing.

VSI

Vertical Speed Indicator, calibrated in thousands of feet per minute when on instruments with no scenery (IFR mode or I key).

ADF

Automatic Direction Finder. Shows the relative direction of the NDB (Nondirectional Beacon) to which it is tuned. The frequency of the NDB is shown at the bottom of the display (388 for example). The location of this NDB is shown on the radar display by the number "0". Its use is described in Chapter 5, NAVIGATIONAL INSTRUMENTS, and Chapter 6, INSTRUMENT FLYING.

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HSI/VOR

Combination HSI (Horizontal Situation Indicator) and VOR (Very high frequency Omnidirectional Range) display. The display toggles with the H key. The frequency of the VOR (or localizer) to which the display is tuned is shown at the bottom of the display (111.10 for example) and the OBS (Omni Bearing Selector) setting is shown at the top (270 for example). The position of the VOR (or Localizer) is shown on the radar display by the number "1". This number is near the east-west ILS Training Field in Figure 1. These instruments include a glide-slope indicator. Their use is described in Chapter 5, NAVIGATIONAL INSTRUMENTS, and Chapter 6, INSTRUMENT FLYING.

VOR

This is the secondary VOR display. The frequency of the VOR to which the receiver is tuned is shown at the bottom of the display (114.90 for example) and the OBS setting is shown at the top (000 for example). The location of the VOR selected is shown on the radar display by the number "2". The use of this instrument is described in Chapter 5, NAVIGATIONAL INSTRUMENTS, and Chapter 6, INSTRUMENT FLYING.

RPM

Engine speed in thousands of revolutions per minute.

THR

Throttle setting, varies between 0 and 1 as the throttle is varied from off to full throttle, respectively.

Stall Warning

A beeper sounds whenever the airplane is stalled.

Note: The navigational aids (NDB, ILS, VOR) are to the left of the numbers (0, 1, 2) which indicate their locations on the radar display.

Basic Airplane Controls and Options

Please note that we have changed the game paddles used for the elevator and aileron/rudder controls from those we used in AIRSIM-1 and SPITFIRE SIMULATOR to conform to what has evolved into a de facto standard for joysticks. Note also, for relating joystick axes to the paddles, that a joystick is just a device for coupling the paddle inputs.

Aileron/rudder

Game Paddle 0. Decreasing readings to roll or turn to the left, increasing readings to roll or turn to the right.

Elevator

Game Paddle 1. Decreasing readings for down elevator, increasing readings for up elevator.

Throttle

The slash (/) key toggles the throttle setting. If the throttle setting is 0, then the / key will toggle the throttle to 100%. If the throttle setting is anything other than 0, the / key will toggle the throttle to 0. The = key causes the throttle to increase gradually, and the - key causes the throttle to decrease gradually. To halt the gradual change of throttle, press any other key.

Brake

The period (.) key activates the brakes when the airplane is on the ground. Pressing any other key releases the brakes.

Radar

The R key activates the radar. The radar view then replaces the scenery. The airplane symbol in the center of the screen shows where the airplane is. To restore the scenery, press the S key.

Radar Scale

The radar scale can be controlled with the keyboard. By radar scale we mean the number of scenery miles displayed within the radar screen. The + key gradually increases the radar scale and the − key gradually decreases the radar scale. The gradual scale-changing process can be stopped by pressing any other key. The @ key or the P key cause the radar scale to be initialized to the value it has when AIRSIM-3 is booted.

Aileron Sensitivity

The A key toggles the aileron sensitivity. The letter "A" will be displayed below the DME when the aileron sensitivity is high, and the letter "A" will be absent when the aileron sensitivity is normal.

Elevator Sensitivity

The E key toggles the elevator sensitivity. The letter "E" will be be displayed below the DME when the elevator sensitivity is high, and the "E" will be absent when the elevator sensitivity is normal.

Flaps

The F key toggles the flaps. The letter "F" will be displayed below the DME when the flaps are active (down), and the letter "F" will be absent when the flaps are not active (up). When the flaps are active, their drag reduces the speed attainable by AIRSIM-3.

Aileron-Rudder Coupling

When you are in the air, the X key toggles the cross coupling between the ailerons and the rudder. The letter "X" will be displayed below the DME when this coupling is in effect. There is no rudder action when you are in the air and the aileron-rudder coupling is not in effect.

Level the Wings

The L key will level the wings when you are in the air. This command is useful when making a landing approach, overcoming an inherent difficulty with AIRSIM-3 in making the wings exactly level with the aileron control.

Look Left or Right

The J and K keys allow you to look left and right, respectively, when you are viewing scenery. A partial view of the wing appears at the top of the screen to indicate that you are looking left or right. Pressing the S key at any time will restore the forward view.

Instrument Flying Modes

A. After booting the AIRSIM-3 disk, or after initializing the program using CTRL-I (discussed below) you will be asked if you want the IFR mode. Press Y for "yes", or N or the RETURN key for "no". If you select "yes" you will have no scenery whenever the plane is at an altitude above 512 ft.

B. The I key will disable the scenery display. The scenery display can be restored at any time by pressing the S key.

The simulation will run significantly faster when the scenery display is disabled because of the elimination of the calculations required by the scenery. The airspeed, the turn-rate indicator and the vertical-speed indicator are calibrated for when there is no scenery display.

Move-with-Joystick Mode

The M key toggles the Move-with-Joystick (or paddles) mode. When this mode is active, an "M" is displayed below the DME. Then the regular airplane simulation stops, and you can move the airplane forward or backward by pushing the joystick forward or backward. Moving the joystick to the left (or right) causes the airplane to move to the left (or right). The use of this mode is described in Chapter 3, A FIRST FLYING LESSON, and Chapter 5, NAVIGATIONAL INSTRUMENTS.

Navigational-Aid Adjustments

The N key allows you to select new navigational aids from the AIRSIM-3 data base shown in Table 1, and to adjust the OBS setting for the VOR displays. This feature is menu driven and its use is described in Chapter 5, NAVIGATIONAL INSTRUMENTS.

Your Approach

The CTRL-Y key selects the Your-Approach mode wherein you can setup your own navigational situations. This mode is menu driven, and its use is described in Chapter 6, INSTRUMENT FLYING.

Pause

The ESC key causes the simulation to pause. The computer will beep to indicate that it has paused. The simulation can be made to continue by pressing RETURN key, the Space Bar, or any key in the two lower rows of the keyboard.

Initialize the Simulation.

The CTRL-I key initializes the simulation to the condition it was in after booting the disk. The computer will then automatically read the Home Scene from the AIRSIM-3 disk

Transport the Airplane.

The CTRL-T key allows you to transport the airplane to a new position. The current position of the airplane will be displayed, and you will be asked to enter new position coordinates. Here X is the distance north (NM), Y is the distance west (NM), and Z is the altitude (ft). Pressing the RETURN key leaves the value unchanged. The origin is at Home or at the end of the runway defined using the Your-Approach mode.

Scenery

There is scenery along the California coast from just south of San Diego to north of San Francisco, as shown in Figure 2 at the center of the manual. The data for this scenery is stored on the disk in the form of 19 local scenes. The scenery data can be accessed by pressing the ESC key followed by a second key, as shown below. The second key should not be pressed until the computer beeps, indicating that it has recognized the ESC key. The program will pause after the beep until a second key is pressed. Pressing any key other than a Scenery key will cause the simulation to continue without reading any scenery data off the disk. The key sequences and the corresponding scenes are as follows (Wait for the beep after pressing ESC):

0. ESC 0

Home, a fictitious region just northwest of Bakersfield, CA. The disk boots with this scene. The Home Scene includes the Home Field (longitude 119° 45' west, latitude 35° 55' north), the Training Field due north of the Home Field, and the east-west ILS Training Field northwest of the Home Field. A range of computer hills lies between the Home Field and the other two fields. The Touch Down Zone Elevation (TDZE) is zero ft. Figure 1 includes a radar map of the Home Scene. Note that North is to the right in this radar map. Figure 3 is an approach chart for the ILS Training Field. (X = 0; Y = 0)

1. ESC 1

Montgomery Field, San Diego. Runway 28R (HDG 281 Deg.) is equipped for ILS approaches. TDZE = 421 ft. Figure 4 is an approach chart for this field. (X = −143.5 NM; Y = −175.1 NM)

2. ESC 2

Daugherty Field, Long Beach. Runway 30 (HDG 301 Deg.) is equipped for ILS approaches. TDZE = 30 ft. Figure 5 is an approach chart for this field. (X = −99.5 NM; Y = −110.8 NM)

3. ESC 3

Los Angeles International Airport. Runways 24L (HDG 249 Deg.) and 6R (HDG 069 Deg.) are equipped for ILS approaches. TDZE = 120 ft. Figure 6 and Figure 7 are approach charts for this field. (X = −99.6 NM; Y = −96.0 NM)

4. ESC 4

Santa Barbara Municipal Airport. Runway 7 (HDG 073 Deg.) is equipped for ILS approaches. TDZE = 10 ft. Figure 8 is an approach chart for this field. (X = −87.1 NM; Y = −20.1 NM)

5. ESC 5

Monterey Peninsula Airport. Runway 10 (HDG 098 Deg.) is equipped for ILS approaches. Figure 9 is an approach chart for this field. (X = 10.5 NM; Y = 111.0 NM)

6. ESC 6

San Francisco International Airport. Runway 28L (HDG 281 Deg.) is equipped for ILS approaches. TDZE = 11 ft. Figure 10 is an approach chart for this field. (X = 61.7 NM; Y = 151.4 NM)

7. ESC 7

Coast line near San Diego. A single line represents the location of Montgomery Field Runway 28R.

8. ESC 8

Coast line between San Diego and Long Beach. A single line represents Long Beach Airport Runway 30.

9. ESC 9

Coast line near Long Beach. A single line represents Long Beach Airport Runway 30.

10. ESC Q

Coast line near Los Angeles. Single lines represent Long Beach Airport Runway 30 and Los Angeles International Airport Runway 24L/6R.

11. ESC W

Santa Catalina and other islands southwest of Los Angeles.

12. ESC E

Coast line near Santa Barbara. A single line represents Santa Barbara Municipal Airport Runway 7.

13. ESC R

Santa Cruz Island and other islands south of Santa Barbara.

14. ESC T

Coast line near San Luis Obispo.

15. ESC Y

Coast line near Monterey. A single line represents Monterey Peninsula Airport Runway 10.

16. ESC U

Coast line from north of Monterey to San Francisco, including the lower part of San Francisco Bay. A single line represents San Francisco International Airport Runway 28L.

17. ESC I

San Francisco Bay. A single line represents San Francisco International Airport Runway 28L.

18. ESC O

Coast line from San Francisco north to Point Arena.

The nine letter keys Q through O are directly below the nine number keys 1 through 9 and can be viewed as representing the nine scenes 10 through 18.

Grid

The G key toggles a grid which overlays the scenery for Scene 0, the Home Scene. The spacing between the grid lines is two nautical miles.

The scenery data, and the locations and characteristics of all navigational aids in AIRSIM-3 were based on the following charts and approach procedures:

1. Los Angeles Sectional Aeronautical Chart.

2. San Francisco Sectional Aeronautical Chart.

3. Instrument Approach Procedures, U.S. Southwest, Vol.1 of 1.

They are publications of the U.S.Department of Commerce. You should be able to order them through your local airport. We recommend that you obtain aeronautical charts because we believe they will greatly enhance your enjoyment of AIRSIM-3.

Crashes

Any impact with the ground with excessive downward-velocity results in a crash. There will be a flash, crash sound, and a message announcing that you've crashed. Recover by pressing CTRL-C. You'll then be back to where you started after booting the disk.

3. A FIRST FLYING LESSON

AIRSIM-3 is a complicated program with lots of options. We think that the best way to learn is by doing. In this section we'll describe a sort of fooling-around exercise which we think will quickly get you familiar with the essentials of AIRSIM-3. At all times, remember to relax and enjoy yourself. If you crash – so what? All you'll have to do is press CTRL-C and you're back in business! Computer-airplane crashes never hurt anybody!

Getting Started

To get started simply boot your AIRSIM-3 disk as described in Chapter 2. Some instrumentation and scenery will appear. Wow! Look at all those instruments! Imagine that you're sitting in the cockpit of your plane, looking forward out of the windshield. Ahead you'll see the runway with some low hills in the background. The runway view is in perspective from close to the ground, so you won't be able to see the runway very well until you are in the air. Press the R key (R for radar). The scenery will be replaced by a radar map. You can control the scale of the radar view. Press the + key and the radar scale will start increasing in 2:1 steps. To halt the scale-changing process, press any key. Press the @ key (or the P key) to initialize the radar scale. The – key will cause the radar scale to decrease gradually. Again, pressing any other key will stop the scale-changing process. Play with the + and – keys to see how the radar scale changes. To see scenery again, press the S key.

You can look sideways. Press the S key if you're not looking at scenery, and then press the J key to look left or the K key to look right. You'll be able to see a bit of the wing when you're looking sideways. Notice the tilt of the horizon; you must be flying a tail dragger. Press the S key when you want to look forward again..

AIRSIM-3 has an optional Grid for the Home Scene. Pressing the G key will toggle the Grid display. Activate the radar (R key) and then press the G key several times. You'll see a Grid appear and disappear as you press the G key. There is a 2 NM spacing between the Grid lines. The calculations required to generate the Grid significantly slow down the computer, and that is why we made the Grid display optional. We enjoy having the Grid when we're doing aerobatics. We usually prefer to do without it otherwise.

Notice the control-position indicator at the lower left-hand corner of the screen. Moving the controls will cause a cursor in that display to move, indicating the position of the controls. Right aileron/rudder-control input will cause the cursor to move towards the letter A on the indicator. Up elevator-control input will cause the cursor to move towards the letter E on the indicator.

Try advancing the throttle to taxi around a bit. To increase the throttle, press the – (right-arrow key); you'll see THR gradually increase one notch at a time. The engine speed (RPM) and the airplane speed (VEL) will also gradually increase. To stop the throttle from increasing, press any key other

than the – key.To decrease the throttle, press the – key, and to stop it from decreasing press any other key than the – key. You can get full throttle in one step if THR is 0 by pressing the / key. Similarly, pressing the / key again will give zero throttle in one step.

Go to zero throttle and press the brake, the period (.) key, to stop the airplane. Advance the throttle one notch to approximately 5%. This will allow you to build up some speed but not enough to take off. Note that hitting the brake (.) still slows the airplane. Pressing any other key releases the brake. Try the aileron/rudder control (Paddle No. 0). Try taxiing the airplane around using the aileron/rudder control to steer the airplane. Cut the throttle to zero and use the brakes to stop the airplane. You'll find that the aileron/rudder control still turns the airplane even when the airplane is not moving.

AIRSIM-3 gives you control of the aileron/rudder sensitivity, the elevator sensitivity, the flaps, and the coupling between the ailerons and rudder. Press the A key, and watch the screen below the DME; the letter "A" will appear and disappear as you press the A key repeatedly. The aileron/rudder sensitivity is normal when the "A" is absent, and high when the "A" is present. Now similarly try the E key and look for the "E" below the DME. When the "E" is absent, the elevator sensitivity is normal; when the "E" is present, the elevator sensitivity is high. We recommend using normal sensitivity until you've become proficient at flying AIRSIM-3. The flaps are controlled by the F key. Try the F key and look for the "F" below the DME. When the "F" is present, the flaps are active (down), and when the "F" is absent the flaps are inactive (up). In Chapter 4 we will discuss the use of the X key which controls the cross-coupling option for the ailerons and rudder; this option is effective only in the air. The aileron/rudder control effects only the rudder when the airplane is on the ground.

Figure 1 shows a radar display of Home, and you can get the same display on your screen. The airplane was at the coordinates X = 5.7 NM, Y = 2.4 NM, and Z = 0; with the airplane heading (HDG) = 270 degrees. We'll transport the airplane to that location using the CTRL-T command. Have the airplane at rest on the ground at Home; press CTRL-I or boot the AIRSIM-3 disk, if necessary, to do this. Activate the radar (R key). Then press CTRL-T to transport the airplane. Enter X = 5.7, Y = 2.4, and just press RETURN to leave Z unchanged at 0. The airplane will jump to the new location. Now turn the airplane to a heading of 270 degrees (HDG = 270) with the aileron/rudder control. Adjust the radar scale if necessary to match the display shown in Figure 1. Notice the numbers 0, 1, and 2 on the radar display. These numbers show the locations of the navigational aids to which the navigational receivers are currently tuned.

SELAHIN ENTERPRISES
PENINSULA PLAZA, SINGAPORE 0617

A Take-off

Use CTRL-I to get the airplane positioned at the south end of the Home Field with the airplane headed north (HDG = 0), ready for a take-off. Alternatively, you can use CTRL-T (X = 0; Y = 0; Z = 0) or taxi the airplane into position. Set the ailerons and elevator to normal sensitivity (no "A" or "E" on the screen) and have the flaps up (no "F" on screen). Apply full throttle (/ key) and watch the plane gather speed. Apply full up elevator. When the airplane reaches about 55 to 60 knots, you'll lift off the ground. The plane may bounce before finally lifting off; some up trim may help if that happens. Adjust the elevator so that you are climbing with the horizon just barely in view. Your climb rate is shown on the Vertical Speed Indicator (VSI). Try to maintain a climb rate of approximately 3000 ft/min (between 2 and 4 on the VSI). Climb over the top of the hill (1000 ft) and then reduce the amount of up elevator to level the plane off gradually, and at the same time use the – key to reduce the throttle setting to approximately 40%. You took off!

Level Flight

After taking off as described above, use the elevator to cruise in a due-north direction (HDG = 0) in level flight with the throttle at approximately 40%. Your airspeed should be approximately 120 knots and your altitude should be about 1200 ft. Practice making small adjustments to the elevator, and see if you can maintain level flight. Observe the altitude and the little triangle next to the altitude. Also observe the VSI. The triangle will point up when you're climbing and down when you're descending.

Please don't overcontrol the airplane! Apply a little up elevator and hold that elevator position constant while you observe how the airplane is going to respond. If this response is not what you wanted, make another small change in elevator position and wait again to see what the response is. Learning how to fly involves developing an intuitive feeling for how the airplane is going to respond. Once you've developed this intuition, you'll no longer need to wait after a control input, because you'll know from experience how the airplane is going to respond. It takes time to develop this feel for an airplane. That's a lot of what learning to fly is all about.

Climbing and Descending via Throttle Control

Once the elevator is adjusted for approximately level flight as described above, try increasing and decreasing the throttle setting. Increasing the throttle will cause the airplane speed to increase, and the airplane will start to climb. Conversely, decreasing the throttle will cause the airplane speed to decrease, and the airplane will start to descend. There are thus two ways to control the altitude of an airplane -- by means of the elevator and by means of the throttle. Experienced pilots know just what throttle settings to use to achieve a desired rate of descent when, for example, making a landing approach. You can learn that too for AIRSIM-3!

A Trip Around Home

AIRSIM-3 has 19 scenes. For now we'll restrict ourselves to the Home Scene (Scene 0). Take off and get into level flight as described above. Figure 1 is a map of the Home scene. We're going to use the transport command (CTRL-T) to take a little trip around Home. Press CTRL-T. You'll be shown your present map coordinates. Respond with X = 0, Y = 0 and Z = 10000 ft. The airplane will jump to a new position, over the south end of the Home Field at an altitude of 10000 feet. Activate the radar with the R key, and you

should see a schematic representation of Home, with you being at the south end of the Home Field and moving north. It might be necessary for you to adjust the radar scale with the +, − or @ keys.

Now we'll take a real computer trip. Get the scenery back again by pressing the S key. Activate the Grid with the G key. Now transport the airplane (CTRL-T) to X = −50 NM, Y = 0 and Z = 16000 ft. Wow! Look at that! (We assume you're flying level to the north as you were told.) That little postage-stamp looking thing up ahead is the Grid as seen from where we are now, far to the south, looking north. Try playing around on your own. Leave the airplane flying level and headed north, and transport yourself around. Use both the S and R keys, with the radar-scale changing commands, to get a feel for the flying space.

Move-with-Joystick Mode (M key)

The Move-with-Joystick mode can be used to transport the airplane around in much the same fashion as the CTRL-T command, but it is more convenient than the CTRL-T command when the objective is to move the airplane to some specific location while observing the radar display. The M key (M for Move) activates or deactivates (toggles) the Move-with-Joystick mode. When this mode is active, the airplane is no longer flying, but its position is controlled by the joystick.

The letter M will be displayed in the lower left corner of the screen when this mode is active. Then moving the joystick forward will move the plane forward and moving the joystick backward will move the plane backward. Similarly, moving the stick left or right will cause the airplane to move left or right, respectively. The rate of motion is proportional to the displacement of the joystick. The rate of motion is also controlled by the radar scale so that as more miles are displayed on the screen (+ key), the plane will cover more miles per step.

This mode can also be used when displaying scenery (S key). You can thus take giant steps across the countryside in any direction you wish. The radar scale still controls the size of the steps.

Caution must be exercised when leaving the M-key mode to insure that the joystick is returned to a position appropriate for flying the airplane. Otherwise the airplane may perform an unexpected and unwanted maneuver.

A California Trip

AIRSIM-3 has scenery along the California coast from north of San Francisco to south of San Diego. We'll explore this scenery now. We recommend that you start this exploration with the plane stationary on the ground at Home. Boot the AIRSIM-3 disk or use CTRL-I to initialize if necessary.

We'll illustrate with a trip to Santa Barbara. Chapter 2, PROCEDURES, INSTRUMENTATION, AND CONTROLS, includes a list of the various scenes available on the AIRSIM-3 disk. There are two Santa Barbara scenes, Scene 4 (ESC 4), which is the Santa Barbara Municipal Airport, and Scene 12 (ESC E) which is the coastline near Santa Barbara. We'll use Scene 4. The scenery list in Chapter 2 indicates that Scene 4 has the coordinates X = −87.1 NM, Y = −20.1 NM for the CTRL-T command.

Load the Santa Barbara Airport scene from the AIRSIM-3 disk by pressing ESC 4. The disk will whirl momentarily, and the Home scenery will disappear. Activate the radar (R key). There is probably still nothing to see except the numbers 0, 1, and 2 indicating the nav-aid locations. You're too far away from Santa Barbara to see it. You could use the CTRL-T command with X = −87.1 NM and Y = −20.1 NM to put yourself near Santa Barbara. Try it. Adjust the radar scale if necessary to get a good view.

The Move-with-Joystick mode (M-key mode) is also useful for positioning the airplane. For a dramatic demonstration, first use the CTRL-T command to go back Home with X = 0, Y = 0. Now increase the radar scale (+ key) until you can see Santa Barbara. Activate the Move-with-Joystick mode (M key) so that the letter M is present below the DME. Now, let's go to Santa Barbara! Move the joystick (elevator and aileron/rudder paddles) so that the cursor in the Control-Position Indicator moves in the right direction to move you towards Santa Barbara. When the radar display indicates that you're there, reduce the radar scale (− key); you'll zoom in towards Santa Barbara. Now again use the M-key mode to move yourself closer to the airport. By repeatedly adjusting the radar scale and using the Move-with-Joystick mode, you can position yourself anywhere in the scene. If you want to determine your X-Y coordinates, use the CTRL-T command and the coordinates will be displayed.

Next let's use the M-key mode to go to Monterey. Load the Monterey airport scenery (Scene 5) from the disk, and increase the radar scale till you can see Monterey. Then use the M-key mode to move yourself to Monterey. Reduce the radar scale (− key) as you get closer to the airport.

We use both the CTRL-T command and the Move-with-Joystick mode frequently. We use CTRL-T to move around the Home scene and to change the altitude of the airplane. We use the M-key mode when moving the plane in conjunction with the radar display.

Turns In the Air

Let's try some turns in the air. Take off (unless you're already in the air!), climb to about 1500 ft, set the throttle to approximately 40%, and adjust the elevator so that you are in level flight with an airspeed of approximately 120 knots. Now let's make a gentle turn to the left. Rotate the aileron control counterclockwise about 20% of its counterclockwise-motion limit. (Move the joystick left about 20% of its leftward-motion limit.) The horizon will appear to tilt clockwise as the airplane rolls counterclockwise, raising its right wing tip and dropping its left wing tip. The airplane is banking to the left. When the airplane has banked so that the horizon is tilted about 30 degrees, center the ailerons. The bank angle will continue to increase momentarily due to the effects of roll inertia, but will soon stop. The airplane will also start to turn. Notice the turn rate. It should indicate that we are turning to

the left (L). However, keep an eye on your rate of climb (VSI) and airspeed (VEL). The airplane is descending and the airspeed is increasing! Unless we do something, we'll enter into a spiral dive, and that we do not want! We want to make a level turn. We have to pull up the nose by applying some up elevator -- not too much. Ideally, we want to coordinate the aileron and the elevator control movements so that the airplane maintains a constant altitude during the turn. Assuming all is going reasonably well for you in this turning process, watch the HDG. When your compass heading reaches due south (180), we'll show you some more computer magic. Ready? If so, level the wings by pressing the L key. Super wow! The wings went level instantly, and we're headed the way we wanted (well, nearly). Anybody can fly! If you feel that is cheating, you can try to come out of the turn the honest way. When you want to stop turning to the left, move the aileron controller to the right so that the airplane starts rolling to the right. When the wings are level, (actually just before the wings are level) center the ailerons. It will take considerable practice before you can end up just where you want to be. It will also be necessary for you to reduce the amount of up elevator as you level the wings, or else the airplane will zoom upwards.

Airspeed Limitations

There are no built-in airspeed limitations for AIRSIM-3. AIRSIM-3 has a top speed in level flight of approximately 195 knots. It takes a long time to attain this speed if you are flying level, but you can reach it more quickly by putting the airplane into a shallow dive. The top speed in a dive is much greater than 200 knots. Find out what it is for yourself.

Well, now that we've gotten you up in the air, you might reasonably ask how you can get down to beloved terra firma again (the ground)! We'll discuss that in Chapter 4, along with how you can even do fancy aerobatics.

4. MORE-ADVANCED FLYING TECHNIQUES

In Chapter 3 we described how to take off, climb, descend, cruise at constant altitude, and turn. Here we'll discuss landings and aerobatics. You'll find it useful to go to your local library and get out a few books about how to fly.

LANDING TECHNIQUES

Perhaps the most difficult maneuver to perform in AIRSIM-3 is landing without crashing! The landing procedure is greatly simplified if the airplane is lined up with the runway so that it is not necessary to use the ailerons; then only the elevator and throttle need be used. You can try landings in AIRSIM-3 without having to use the ailerons at all! We've provided you with a Training Field straight ahead of the Home Field so that you can practice landings without having to make any turns. Let's try it!

Boot AIRSIM-3 or initialize with CTRL-I to get yourself at the south end of the Home Field facing due north. Ahead of you is the Training Field on which you are going to attempt to land. Remember that you should not have to touch the ailerons, because no turns are necessary to reach the Training Field. If you are a beginner and do somehow manage to upset the airplane so that aileron control is necessary, you would probably be wise simply to initialize (CTRL-I) and start over again.

The Spot-on-the-Windshield Method

Take off from the Home Field, climb until you have just passed over the top of the hill beyond the runway, and then level off at around 1200 ft. Reduce the throttle to approximately 40%. You should see the Training Field straight ahead and below you.

Now would be a good time to pause using the ESC key while we discuss what you're going to do next. We're going to use what is called the "spot-on-the-windshield method" to make our approach to the Training Field. The basic idea of the method is simple. We want to set up our approach so that the airplane follows a straight line which starts where we are and ends at the nearest end of the runway we're approaching. Imagine a point in the center of the windshield. If we fly so that this point always lies on an object we're approaching, then we'll eventually fly the airplane right into that object. That's exactly what we want to do; well, almost exactly. We want to fly our airplane right into the nearest end of the runway, except that we want also to level off at the last moment to avoid a crash. That leveling-out process is called "flaring out".

The Descent

OK! Lets try it. (Press the space bar on the keyboard to continue.) Ahead you should see the Training Field approaching you gradually. Lower the flaps by pressing the F key. An "F" will appear on the screen if the flaps are active. Lowering the flaps will cause two things to happen. An increase in [illegible] will slow the airplane down, and an increase in lift will cause the

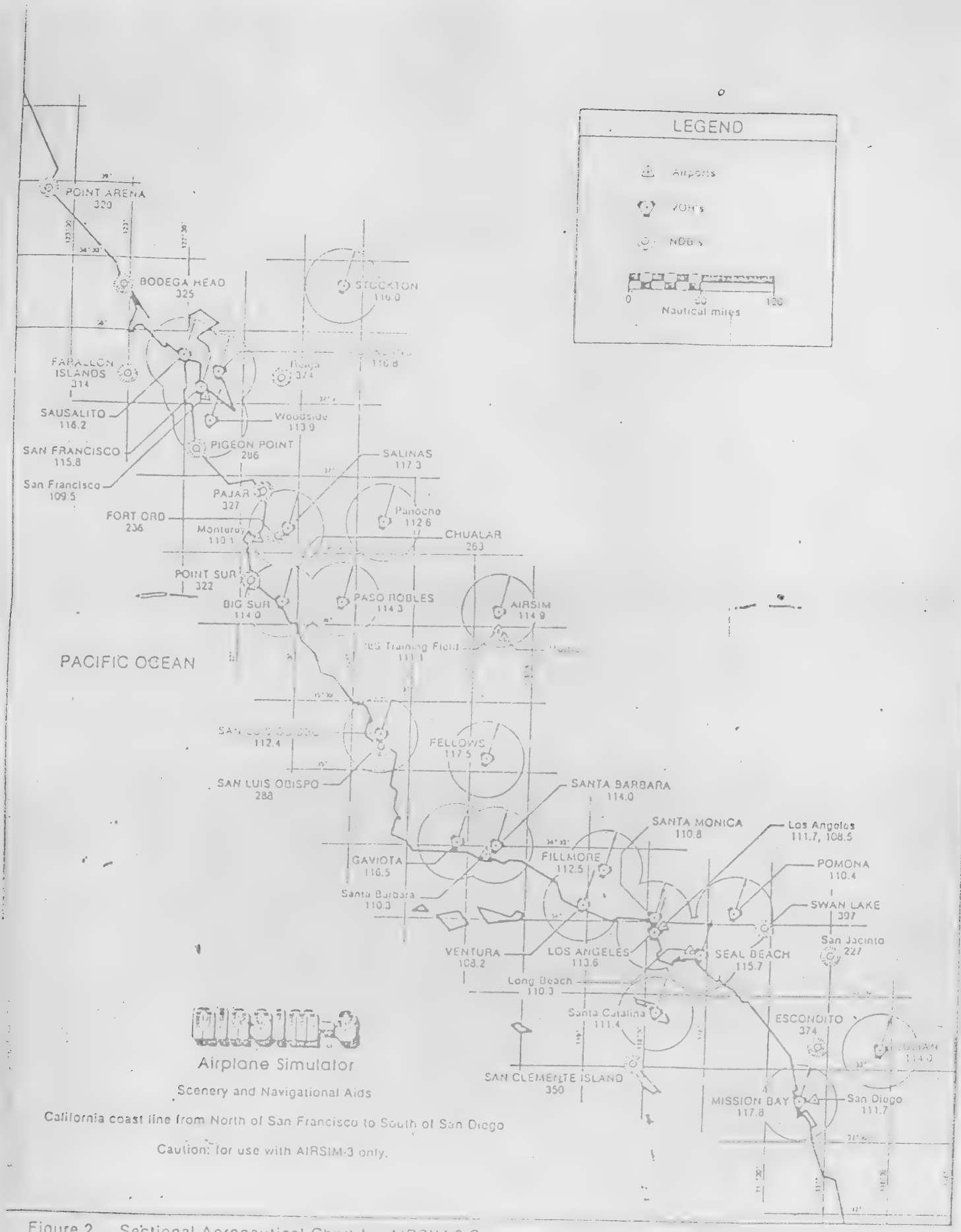

Figure 2. Sectional Aeronautical Chart for AIRSIM-3 Scenery.

airplane to rise momentarily. Use the elevator control to lower the nose of the airplane gradually so that the imaginary spot on the windshield is aligned with the image of the nearest end of the Training Field. Leave the throttle at approximately 40%. You'll need that power to pull the airplane along with the increased drag due to the flaps.

The VSI should indicate a descent rate of about 1000 ft/min during this descent. Try to make a nice steady descent right to the nearest end of the runway -- keep it right on that imaginary spot on the windshield. If you get too messed up, you can always raise the flaps (F key) and use CTRL-T to transport yourself back to near X = 0, Y = 0 and Z = 1200 ft, which is a good location for making another attempt. Alternatively, you can initialize using CTRL-I, thus starting all over again from the Home Field.

The Flareout and the Touchdown

Let's assume you've descended to an altitude of about 200 ft and the runway is looming up fast. Now we want to "flare out" to settle down to the ground. Gradually give up elevator to pull up the nose of the plane. Adjust the elevator gradually -- don't overdo it! Try to attain and keep a descent rate of approximately 500 ft/min. Don't move the elevator back too far or you'll zoom up and perhaps even stall, far off the ground. You want to let the airplane settle gently onto the runway. Your airspeed should gradually decrease. When your altitude gets to about 10 or 15 ft, cut the throttle with the / key. Try then to hold the airplane just off the ground as long as possible by giving more and more up elevator. Don't worry about running out of runway. The Training Field is very long. If you're successful, you'll settle gently onto the runway with an airspeed of less than 50 knots without a bounce. If you touch the ground at more than 60 knots, you may bounce. If you do bounce, don't overcontrol the elevator. Make small control motions and wait to see how the airplane is going to respond. Once you're on the ground, apply the brakes. The airplane will then quickly come to rest. You can use the radar (R key) to see where you ended up.

To try another landing, you can use CTRL-I to reinitialize, or use CTRL-T with X = 0, Y = 0, Z = 0 to take you back to the Home Field.

You should practice landings until you can make them reliably. Take special note of how the perspective view of the runway presents itself to you during each approach. The Home runways are at zero altitude, whereas the other airports are not. It will be difficult to use the altimeter for guidance when landing at these other airports. The situation is complicated due to the absence of ground texture in the display. Develop an intuitive feeling for how the perspective view of the runway is related to your altitude above the ground during landings.

Advanced Landing Techniques

It is one thing to make a successful landing on the Training Field after taking off from the Home Field when you've left the ailerons alone so that you remain lined up with the Training Field. What do you do if you've been brave enough to fiddle with the ailerons? We've tried to address that problem in AIRSIM-3. We've provided a bit of computer magic called the L command which levels the wings instantly when activated by pressing the L key.

Imagine you are flying west (HDG 270) and want to land at the Home Field. Bank to the right so that the airplane turns north. When you are headed north (HDG 0), center the ailerons and press the L key. Your wings will become level in one step! If your course is not exactly correct, turn again but more gently this time, and when your course is right press the L key again. As you gain experience, you'll be able to attain leveled wings and the desired course in one step. Once you are on the right course, heading for your landing approach, you can use the CTRL-T command or the M-key mode to transport yourself to the right position for a landing approach. If you think that is cheating, you always have the option of doing it honestly! We just gave you the options; it is for you to decide what you want to do! After you become proficient at flying, you'll probably want to use the "L" command just to overcome the difficulty inherent in AIRSIM-3 in making the wings exactly level when they are just a little off being level. That's not cheating!

Coupled Ailerons and Rudder

When you are in the air, you have the option of having either aileron control without any rudder action, or aileron control with coupled rudder action. This cross-coupling option is toggled by the X key. When this option is active, an "X" will appear on the screen below the DME.

You'll have to gain some experience with AIRSIM-3 to decide how you want to use this option. If we're flying with the wings level and want to initiate a roll without initiating a turn, we want ailerons only, with no rudder action (X command not active). If we are in a turn and want to roll out of the turn without turning any further, then we want aileron-rudder coupling (X command active). The effects of the command are subtle but useful.

AEROBATICS

AIRSIM-3 can perform many of the standard aerobatic maneuvers. Here the advantage of a computer airplane over a real one becomes very apparent, especially if you get airsick!

The Loop

Our favorite aerobatic maneuver is the loop. You won't need the ailerons at all if your airplane is flying with wings level and steady. Advance the throttle to 100% and climb to 1000 ft or more. Once you are at altitude, go into a gentle descent, still at full throttle, and let the speed build up to 160 knots or more. Then gradually and steadily give more and more up elevator until the elevator is full up. Don't move the elevator too quickly, especially if the elevator sensitivity is high (E key and letter "E" present) or you may get a high-speed stall.

With the elevator full up, the ground will quickly disappear and all you'll see out of the windshield is sky. The airspeed will gradually decrease. Soon, however, you should see the horizon appear again as you pass over the top of the loop. You are now upside down, hanging in your seatbelt harness. You should soon be able to see the ground above you. Your airspeed should now gradually increase. Continue to hold full up elevator and cut the throttle so your airspeed won't get too high. If you're above a runway, you'll see the ground rush up to meet you as you dive down, and then pass under you as you level out. As you do level out, bring the elevator back to near its central position and maintain level flight. Restore the throttle. You just made a loop!

We like to have the Grid present (G key) and look sideways (J or K key) during the loop.

Outside Loop

Outside loops are easy too. Use the CTRL-T command to transport yourself to an altitude of 5000 ft above the Training Field (X = 5, Y = 0 and Z = 5000). Cut the throttle and gradually apply full down elevator. The plane will nose over, dive down, and gradually go upside down so that you can see the ground above you. When you reach the the bottom of the loop, apply full throttle and continue to hold the full "down" elevator. Wait for the airplane to complete its outside loop by climbing up until you can see the horizon with the ground now below you again. That was the dreaded outside loop.

Inverted Flight

Now try inverted flight. There are two ways you can achieve this. You've already done one; do half a loop. When you see the horizon with the ground above you, apply down elevator (yes down elevator!) to make the airplane maintain level flight. Once you've got the airplane inverted and maintaining approximately level flight, try flying around in inverted flight. You'll find that AIRSIM-3 does not fly anywhere near as well inverted as it does right-side up! There are two ways to right the inverted airplane. You can do a half loop, or you can roll right-side up.

Rolls

The other way to get inverted is by doing a half roll. We recommend that you use high aileron sensitivity. We'll illustrate by doing a half roll to the right. Get the airplane into level flight at approximately 40% throttle. Apply full right aileron (rotate the aileron controller fully clockwise) The horizon will start to rotate counterclockwise as the plane rolls clockwise. When the horizon has rotated about 45 degrees, get ready to stop the rolling motion by bringing the ailerons back to center, or even a bit beyond center. In this way stop the rolling motion and keep the wings level with the airplane upside down. Simultaneously, apply some down elevator to hold the nose up as the plane rolls over upside down.

AIRSIM-3 does very nice rolls. We'll illustrate again with a full roll to the left. Get the airplane into level flight at full throttle (Here comes some fast stuff!). As the airplane rolls counterclockwise, the horizon will appear to rotate clockwise. The tricky part of rolling concerns what you do with the elevator. When the airplane is upside-down, you'll have to apply down elevator to keep the nose of the airplane up! So, as the airplane rolls from being right-side up to being up-side down, you want to move the elevator gradually from being up to being down. Also, as the airplane completes rolling from being up-side down to being right-side up, you want to move the elevator gradually from being down to being up! Experienced pilots coordinate the elevator position with the roll position so that the airplane closely maintains level flight throughout the roll. It's a difficult maneuver to perform well, i.e. without large changes in altitude.

Stalls

It's important to become familiar with stalls when flying, because you may otherwise accidently stall the airplane and crash. To try a stall, get into level flight at 100% throttle at 2000 ft or more altitude. Use high elevator sensitivity (E key). When the speed has built up to more than 120 knots, cut the throttle (/ key) and climb at a small angle. The airspeed will gradually decrease. As it does so, continually apply more and more up elevator so that the airplane maintains approximately a constant climb angle, with the horizon in view. The airspeed will keep dropping. Eventually the airplane will stall. There will be a beeping sound (the stall warning) and the nose will drop. Notice the speed at which the airplane stalled. We find that AIRSIM-3 stalls at about 50 knots in this experiment. When the airplane stalls, immediately apply full down elevator and full throttle. The nose will drop and the airspeed will increase. As soon as the airspeed builds up to well above the stall speed, apply gradual up elevator to pull the nose up into level flight. If your altitude was too low when you entered the stall, you will not have sufficient altitude to pull out, and guess what will happen to you then!

AIRSIM-3 does very nice stalls as long as you don't ask too much from the equations of motion. You are asking too much if you let the airspeed become negative. Also, the equations do not represent a situation in which every lifting surface is stalled. If you do get the airplane into one of those situations, the equations of motion will just grind out nonsense, and you will probably crash! Thus, for example, never allow the airspeed to become either too small or negative. No lomcevak's, please! No tail slides, either.

ATTITUDE INDICATOR

The Attitude Indicator, also known as an artificial horizon, provides information about the attitude of the airplane. It tells whether the airplane is climbing or descending, and whether the wings are level or the airplane is banked. The Attitude Indicator is shown in Figure 1. There are two elements in the Attitude Indicator. The first element is a small end-on view of an airplane which never moves and serves as a reference. The second element represents the horizon and the ground, and moves as the airplane climbs, dives and banks. The Attitude Indicator is an easy instrument to use. In in-

terpreting it, imagine you are behind the airplane and looking forward along the centerline of the airplane. If the airplane symbol is above the horizon, the airplane is climbing. If the airplane symbol is below the horizon, the airplane is diving. If the airplane is banked, the horizon is rotated. The Attitude Indicator is especially useful when making turns.

MISCELLANEOUS FUN

We have a lot of fun just flying AIRSIM-3 around in a hell-bent-for-leather fashion. A flight simulator gives you a freedom to fool around that is not available when flying a real airplane. We'll describe below a few of the many miscellaneous possibilities that exist for enjoying AIRSIM-3.

We've had a lot of fun flying AIRSIM-3 close to the hills at Home. These are "wire-frame" hills; you can fly right through them! We like to fly through a hill, bank around, and fly through the adjoining hill, zig-zagging through the range of hills like passing a thread through a series of needle eyes. It's a lot like pylon racing.

Another maneuver we've enjoyed is a loop in which we fly through a hill, loop up over it, and pass through the hill again at the bottom of the loop. If this does not challenge you sufficiently, try an outside loop which passes through a hill at the bottom of the loop!

AIRSIM-3 can perform an Immelmann turn. This is half a loop (so you are upside down and headed in a reversed direction) followed by a half roll at the top of the half loop to right the airplane. This will cause the instrumentation to behave strangely.

You can perform many loops consecutively with AIRSIM-3. We have started it looping and then left it on its own, doing loop after loop unattended. The plane usually runs out of altitude eventually.

AIRSIM-3 has a absolute ceiling slightly above 20,000 ft. You could try for an altitude record. You can use CTRL-T to get yourself up to around 16000 ft. You'll have to fly from there on up. There are techniques which creative souls could use to set a record which would be hard to beat. We think that if you stall and can't recover, then you don't have a record. We'd enjoy hearing from record claimants. We'll try to respond to all reasonable record claims.

5. NAVIGATIONAL INSTRUMENTS

In this chapter we'll describe how the various navigational instruments in AIRSIM-3 operate. In the next chapter we'll illustrate how these instruments can be used. We warn all AIRSIM-3 users that the discussion in this chapter and the next is intended only to indicate how AIRSIM-3 operates. It is necessary to receive instruction from qualified flight instructors regarding the proper use of actual aircraft instrumentation and instrument-flight procedures before using them in real aircraft flight.

The Instrument Panel Revisited

We discussed the instrument panel in Chapter 2, but here we'll focus on the instruments of primary concern for navigation. These are the Automatic Direction Finder (ADF), the VOR display, and the HSI/VOR display with a Glide-Slope Indicator. Please refer to Figure 1 during this discussion. These instruments will be introduced in this section. Their use will be illustrated in Chapter 6, INSTRUMENT FLYING.

ADF Display

The ADF display is in the upper right-hand corner of the screen, and is denoted by "0" in Figure 1. There are 12 dots equally spaced on the circumference of a circle so that there are 30 degrees between dots. There is an indicator needle spanning this circle and a marker at the head of the needle. The number at the bottom of the ADF display (388.00 in Figure 1) is the frequency (KHz) of the Nondirectional Radio Beacon (NDB) to which the ADF is tuned. An NDB is a radio station which radiates uniformly in all directions.

The basic interpretation of the ADF is simple. The ADF is tuned to the frequency of a selected Nondirectional Radio Beacon (NDB) and the head of the ADF needle then indicates the relative bearing of that beacon relative to the airplane. In Figure 1 the NDB having a frequency of 388 KHz is behind the airplane in a direction approximately 30 degrees to the left of the tail of the airplane. The needle always points towards the NDB. The location of the NDB is shown by the number "0" on the radar display in Figure 1.

VOR Display

The VOR display is two instruments down from the ADF display, and is denoted by "2" in Figure 1. We'll denote this VOR display as the secondary VOR display, because we also have another VOR display in the HSI/VOR display, and we'll call that the primary VOR display.

VOR is the abbreviation for Very high frequency Omni-directional Range. This range broadcasts two signals, one of which is an omnidirectional pulse with a pulse rate of 30 Hz, and the other of which is a narrow and highly directional beam which rotates around the VOR at 30 revolutions per second. The VOR receiver, called an omni receiver, uses the delay between the receipt times of these two signals to calculate the radial direction from the VOR to the airplane. There are 360 possible radial directions, and these are called the "radials" for the VOR.

The VOR display is composed of four parts: 1) Frequency Indicator (114.90 MHz in Figure 1). 2) Omni Bearing Selector (OBS, 000 degrees in Figure 1). 3) Course-Deviation Indicator, which is a needle pivoted at its upper end (inclined to the left in Figure 1). 4) To-From Indicator, the letter T or F (T in Figure 1). We'll postpone further discussion of the VOR display until the Section below on exploring the VOR with the M-key (Move-with-Joystick) mode, which will help illustrate how the VOR display functions.

HSI/VOR Display

The HSI/VOR display is directly under the ADF display and is denoted by "1" in Figure 1. This display is actually two displays in one, in which the desired display can be selected in toggle fashion by pressing the H key. The disk boots with a display of the HSI, and pressing the H key will activate the VOR display. Repeated pressing of the H key will toggle these two displays. Figure 1 shows the HSI display.

HSI is the abbreviation for Horizontal Situation Indicator. The HSI is composed of 6 parts: 1) Frequency Indicator (111.10 MHz in Figure 1). 2) Omni Bearing Selector (OBS, 270 degrees in Figure 1). 3) Course Arrow. 4) Course-Deviation Bar, to the left side of the HSI in Figure 1. 5) The Station Indicator formed by 4 dots arranged in a cross; one of the dots in this cross is obscured in Figure 1. 6) Glide-Slope Indicator, a small solid triangular marker which moves vertically along 5 vertical dots; this marker is located on the uppermost of these 5 dots in Figure 1.

The VOR display for the HSI/VOR display is identical to the other VOR display with the exception that it also includes a Glide-Slope Indicator in the form of a needle pivoted at its left-hand end with the other end moving vertically as does the glide-slope marker in the HSI.

The HSI/VOR display provides alternate displays which are almost equivalent to each other. The HSI is a more recent development than the VOR, however the HSI is as yet rarely found on private airplanes. The behavior of the HSI/VOR display will be illustrated below in the section on exploring the HSI using the M-key (Move-with-Joystick) mode.

Selecting Navigational Aids (N Key)

The N key (N for Navigational Aids) permits you to select new navigational aids or to make adjustments to the OBS values you are using. In real aircraft, navigational aids are selected by tuning a receiver to an appropriate frequency. In AIRSIM-3, navigational aids are selected from Table 1 using the N-key command. In real aircraft, the OBS value is selected by adjusting a knob on the VOR display; whereas, in AIRSIM-3, the OBS values are selected using the N-key command with the joystick and the keyboard.

Press the N key. You will see a display which asks if you want to select a localizer (LOC) or VOR for the HSI/VOR display (primary VOR display). The numbers 1-8 refer to localizers as given in Table 1. The remaining numbers 9-28 refer to the VOR's given in Table 1. Either enter the number of the localizer or VOR you wish to use, or simply press the RETURN key without entering a LOC or VOR number to leave the selected LOC/VOR unchanged from its current value. You will then similarly be asked if you want to change the VOR for the lower or secondary VOR display. Pressing just the RETURN key will leave the selected VOR unchanged.

You will then be asked if you want to select a new outer marker (LOM) or NDB. You can select a new outer marker or NDB, from Table 1, or simply press the RETURN key to leave the LOM/NDB unchanged. You will then be given the opportunity to adjust the OBS for the VOR display or the HSI display. You will first be asked if you want to adjust the OBS using elevator control (ELEV CONTROL). Pressing the RETURN key is equivalent to saying "No". Pressing any other key will cause the instruments to be displayed. Then manipulate the elevator control and observe the OBS on the VOR display. It is a coarse setting, useful for setting the OBS approximately. It is useful, for example, for determining which VOR radial your airplane is on. You can also make fine adjustments to the OBS using the left-arrow and right-arrow keys. Press the RETURN key when you wish to stop. The OBS is now set. You'll be warned to reset the airplane controls to reasonable values for flying the aircraft. You will then be asked if you wish to enter a value for the OBS from the keyboard. Either enter a value, or press the RETURN key immediately if you wish not to use this option.

You won't be given the opportunity to adjust the OBS for the HSI/VOR display if it is tuned to a localizer, because the OBS for a localizer is fixed to the runway heading by the ILS

Exploring the ADF with the Move-with-Joystick Mode

The Move-with-Joystick mode is marvelous for exploring quickly how the navigational instruments behave. This mode can be used at any time, but we recommend that the airplane be at rest, on the ground at Home with zero throttle, for the exercises described below. Activate the radar display.

Locate the NDB (the number "0") on the radar display, adjusting the radar scale if necessary. The boot value of the radar scale is ideal.

Activate the Move-with-Joystick mode with the M key so that "M" is displayed below the DME. Move the joystick so that the airplane moves towards the NDB. Manipulate the joystick so that the airplane moves around the NDB while remaining some distance away from it. Notice that the ADF needle always points in the direction of the imaginary line going from the airplane to the NDB.

Leave the Move-with-Joystick mode by pressing the M key so that the M is absent from the screen. Then use the joystick to turn the airplane to a new heading. Reactivate the Move-with-Joystick mode and repeat the experiment described above. You'll find that the ADF needle behaves in the same fashion, always indicating the bearing of the NDB relative to the airplane.

Thus you can easily see how an ADF can be used in navigation. To fly an airplane to an NDB you simply turn the airplane until the ADF needle indicates that the NDB is ahead of the airplane. It is easy to tell when the airplane has passed by an NDB by observing the swing of the ADF needle.

You could determine the location of an airplane on a chart by tuning the ADF to several NDB's and plotting the relative bearings of each of these NDB's.

Exploring the VOR Display with the Move-with-Joystick Mode (M key)

Use the Home Scene with the initial value of the OBS of 000 for the secondary VOR display for this introduction to the VOR. Have the airplane at rest on the ground with zero throttle. The behavior of the VOR display does not depend on the airplane heading; however we recommend initially that you have the airplane heading north (HDG = 0). Locate the VOR (No. "2") on the radar display, adjusting the radar scale if necessary.

Activate the Move-with-Joystick mode with the M key. Use the joystick to move the airplane so that it is approximately south of the VOR (No."2"). We're going to do some experiments first to explore the behavior of the To-From indicator. Then we'll do some experiments to explore the behavior of the Course-Deviation Indicator.

Our VOR display (or omni receiver) is tuned to Airsim VOR ("2") which has a frequency of 114.9 MHz. We have selected an OBS (Omni Bearing Selector) of 000, which means 0 degrees (north). The VOR display gives us information about the position of our airplane relative to a radial line which originates at the VOR and has the bearing we specify with the OBS. Look at Figure 2, the AIRSIM-3 Sectional Chart at the center of this manual. Look at the symbol representing a VOR. This symbol has an arrow which originates at the VOR and has the magnetic bearing of 0 degrees (north). The VOR symbol is the VOR radial with the local magnetic-north heading. The OBS need not always be north; it can have any value.

With the airplane south of the VOR and the OBS set to 000, the To-From indicator shows T for "To". The VOR display is telling us that if we move northward, we will be moving To the VOR. Move the airplane northward till it passes north of the VOR, and note that the To-From indicator changes from T to F when the airplane is north of the VOR. When it displays the letter F the VOR display is telling us that moving northward (in the OBS direction) will take us From the VOR.

Now try moving the airplane all around the VOR using the joystick and the M-key mode. Notice that whenever the airplane is south of the VOR the To-From indicator shows a T for "To", and that whenever the airplane is north of the VOR the To-From indicator shows an F for "From". If we had selected a different value for the OBS, the behavior of the VOR display would have been the same as in the above experiment with the exception that, instead of changing relative to the radial directed out of the VOR to the north, it would change relative to the radial specified by the OBS.

Now, let's use the M-key mode to explore the Course-Deviation Indicator on the VOR display. Position the airplane to the south west of the VOR (To-From should be T). Move the airplane to the east with the joystick and observe how the Course-Deviation Indicator on the VOR display behaves. The Course-Deviation Indicator should swing to the left. Now use the joystick to move the airplane to the west. The Course-Deviation Indicator will swing to the right, passing through a vertical position when the airplane is due south of the VOR. Move the airplane back and forth this way several times, until you get a good intuitive feeling for how the position of the Course-Deviation Indicator is related to the airplane position. The needle is actually indicating the angular deviation of the airplane from a position where it is due south of the VOR. To see this, move the airplane further south of the VOR and then repeat the east-west motion experiment. The Course-Deviation Indicator will still swing, but more gradually as the airplane is moved further south of the VOR. The full-scale deflection of the Course-Deviation Indicator occurs at 10 degrees deviation.

Next use the joystick to move the airplane so that it is north of the VOR and repeat the east-west experiment. The Course-Deviation Indicator will behave exactly as it did when the plane was south of the VOR, being centered when the airplane is due north of the VOR. The only difference is that the To-From indicator will be F for "From" when the airplane is north of the VOR, whereas it was T for "To" when the airplane was south of the VOR.

What does all this mean? Recall that the OBS was set to 000. That means we had selected the radial line originating at the VOR and going out from the VOR in the direction of magnetic north(0 degrees). If we are south of the VOR, the To-From indication of T tells us that going north (the OBS value) will take us To the VOR. When the To-From indicator switches to F, that tells us that going north (the OBS value) will take us From the VOR. If the Course-Deviation Indicator is centered, that means we are right on the line that includes the OBS radial. If the Course-Deviation Indicator is not centered, that means that we are off to one side of that radial. For example, if we select due north for our OBS radial and fly due north, we would see the Course-Deviation Indicator point to the right if the VOR due-north radial is to our right.

The simplest use of the VOR involves using it to fly from one VOR to another. To do this you setup the OBS radial you want to follow to take you to a VOR and fly the airplane so as to keep the Course-Deviation Indicator centered. You watch the To-From indicator to tell you when you've passed the VOR. Then you tune to the next VOR on your route and set the OBS to take you over it, etc. The aeronautical charts include the OBS settings to take you from VOR to VOR, a network of electronic highways. Each such highway even has an identification like the automobile highways!

The VOR is also used to locate the intersections of these electronic highways. These intersections are usually assigned names, and are often used for making landing approaches, as we shall illustrate in Chapter 6, INSTRUMENT FLYING.

As an exercise, we recommend you use the N-key command to set the OBS to 090 (due east) and repeat the experiments described above. Everything should work out to be the same as it did above if you just rotate your viewpoint 90 degrees to the east. For example, initially put yourself to the west of the VOR (instead of to the south) and use the joystick to move the airplane north and south (instead of west and east). If you have trouble, pretend you're playing an aeronautical Adventure-type game!

The VOR for the HSI/VOR display works in exactly the same fashion as the VOR display described above. The only difference is that the OBS is fixed when the HSI/VOR display is tuned to a localizer, the OBS value being the course for approaching the runway.

Exploring the HSI Display with the Move-with-Joystick Mode (M key)

Use the Home Scene with the initial value of 270 for the OBS for the HSI/VOR display for this introduction to the HSI (Horizontal Situation Indicator). Have the airplane at rest on the ground with zero throttle. Boot the AIRSIM-3 disk if necessary to achieve this. Use the aileron/rudder control to turn the airplane to a heading of 300 deg (HDG = 300). Activate the HSI display by pressing the H key if the HSI is not displayed. Find the localizer on the radar display ("1"), adjusting the radar scale if necessary.

Activate the Move-with-Joystick mode with the M key. Use the joystick to move the airplane so that it is in line with the ILS Training Field and to the east of the localizer ("1"). The Course Arrow will indicate the OBS course relative to the heading of the airplane. The Station Indicator (4 dots in a cross) should lie on the head of the Course Arrow indicating a "To" condition. The To-From condition for the HSI display is identical to that for a VOR. You can easily verify this by switching between the HSI and VOR with the H key.

Now move the airplane to the north with the joystick and observe how the Course-Deviation Bar on the HSI behaves. Imagine you are looking along the Course Arrow, from the tail towards the head. The Course-Deviation Bar should move to the left of the Course Arrow, indicating that the desired course (as set by the OBS) is now to the left of the airplane. Now use the joystick to move the airplane to the south. The Course-Deviation Bar should move back towards the Course Arrow, passing over the Course Arrow and to its right as the airplane passes over the line including the 270 degree radial. Move the airplane back and forth on a north-south line several times this way until you get a good intuitive feeling for how the position of the Course-Deviation Bar is related to the airplane position. The bar is actually indicating the difference between the localizer radial to the airplane and the localizer radial where the airplane would be colinear with the 270-degree localizer radial. The full-scale deflection of the bar occurs at 2.5 degrees for a localizer and at 10 degrees for a VOR. If you move the airplane far to the east and repeat the experiment described above, you'll find that the behavior of the Course-Deviation Bar is unchanged with the exception that it moves more slowly with changes in position.

Next use the joystick to move the airplane so that it is west of the localizer and repeat the north-south experiment. The Course-Deviation Bar will vary exactly as it did when the plane was east of the localizer. The only difference is that the Station Indicator has moved to the tail of the Course Arrow indicating a From condition. Verify this by pressing the H key to activate the VOR display, which should now display an F in its To-From indicator.

What does all this mean? Recall that the OBS was 270, the due-west ILS course for approaching the ILS Training Field. This OBS is a radial line originating at the ILS going out from the ILS in the direction of magnetic west (270 degrees). If we are due east of the ILS, the To-From indication of T (Station Indicator at the head of the Course Arrow) tells us that going west (the OBS value) would take us To the VOR. When the To-From indicator switches to F (Station Indicator at the tail of the Course Arrow), that tells us that going west (the OBS value) will take us From the ILS.

The positions of the Course-Deviation Bar and the Station Indicator relative to the Course Arrow do not depend on the heading of the airplane.

The HSI Course Arrow is affected by the airplane heading. In fact, the Course Arrow shows the orientation of the OBS course relative to the airplane, information not provided by a VOR display.

You can use the Move-with Joystick mode to illustrate how you can make an instrument approach to a runway using an HSI. Set up the Home Scene with the airplane at rest on the ground with the HSI display active. Activate the radar (R key). Use the CTRL-T command to transport the airplane to X = 2.6 NM, Y = −1.8 NM, Z = 0. Use the aileron/rudder control to turn the airplane to a heading of 300 degrees (HDG = 300). The airplane position and heading are now such that the airplane has to move forward to intercept the 270-degree course for approaching the ILS Training Field. The HSI Station Indicator is on the head of the Course Arrow, indicating that the airplane is in a "To" condition relative to the ILS ("1"). The Course-Deviation Bar is to the right of the Course Arrow, indicating that the 270-degree radial (the approach course) lies to the right of the airplane.

Now activate the Move-with-Joystick mode with the M key. Nudge the joystick forward so that the airplane moves forward slowly, and observe how the HSI behaves as the airplane nears and crosses the approach path for the ILS Training Field. The Course-Deviation Bar will sweep from right to left, crossing the course arrow as the airplane crosses the approach path. Move the airplane back and forth several times until you get a good intuitive feeling for how the Course-Deviation Bar behaves.

If you wanted to land at the ILS Training Field, you would have to turn the airplane left from the 300-degree heading to the 270-degree approach heading as the plane neared the approach path. Position the airplane so that it is on the approach path for the ILS Training Field, with the Course-Deviation Bar centered on the Course Arrow. Then press the M key to disable the M-key mode. Turn the airplane to a 270-degree heading with the aileron/rudder control. Enable the M-key mode again, and move the airplane forward, as though you were making a landing approach. Notice how the Course-Deviation Bar behaves. If it moves to one side, correct the airplane position to keep the Course-Deviation Bar centered as you approach the runway. You'll hear a 1300 Hz tone and see an X in the MM box if you pass over the Middle Marker.

The previous two sections described how the VOR and HSI can provide information to enable the pilot to tell whether the plane is to the left or right of the desired course. An Instrument Landing System (ILS) also provides information to enable the pilot to tell whether the plane is above or below the proper path, called the glide-slope path, for approaching the runway. This glide-slope path is typically, but not always, inclined at an angle of 3 degrees.

Glide-Slope Instrumentation is very simple. It consists either of a marker or a pivoted needle which moves above the reference position when the glide-slope path is above the airplane, and moves below the reference position when the glide-slope path is below the airplane. This marker or needle rests on the reference position when the airplane is on the glide-slope path.

The HSI and the VOR display in the HSI/VOR display each include a Glide-Slope Indicator. Use the H key to display the HSI in the HSI/VOR display. The HSI Glide-Slope Indicator consists of a moving triangular glide-slope marker and 5 equally spaced dots arranged vertically at the left side of the HSI. The center dot forms the reference position for the Glide-Slope Indicator. The glide-slope marker in Figure 1 rests at the uppermost dot and indicates that the glide-slope path is above the airplane. This is to be expected, since the airplane was on the ground at the time.

The Glide-Slope Indicator for the VOR display in the HSI/VOR display utilizes a glide-slope needle pivoted at its left end. The needle is horizontal when the glide-slope path is at the same level as the airplane. The free end of the needle swings upward when the glide-slope path is above the airplane, and downward when the glide-slope path is below the airplane. Press the H key to display the VOR in the HSI/VOR display, and observe that the glide-slope needle is inclined upward. This indicates that the plane is below the glide-slope path, which is to be expected since the airplane is on the ground.

In principle, it is easy to use the Glide-Slope Indicator. If it indicates that the glide-slope path is below the plane, the pilot must make the plane descend more quickly. If the Glide-Slope Indicator shows that the glide slope is above the plane, the pilot must make the plane descend less quickly. In actual practice, it requires considerable skill to keep a plane right on the glide-slope path. Beginning pilots will inevitably overcontrol the airplane and wander widely above and below the glide slope. It takes a lot of experience to know what combination of throttle and control settings will cause the airplane to fly smoothly down the glide-slope path.

There is another problem with the Glide-Slope Indicator. The glide-slope equipment gives false glide slopes at angles greatly larger than 3 degrees.

[illegible] expect to intercept the true glide-slope path. This information is pro[illegible] on the airport approach charts, examples of which are presented in [illegible].

The behavior of the AIRSIM-3 glide-slope instrumentation can be explored nicely using the Move-with-Joystick mode. Use Scene 0 with the ILS located at the ILS Training Field. Takeoff and use the CTRL-T command to put the airplane at 1000 ft altitude. Then press the M key to enable the Move-with-Joystick mode. Position the airplane on line with the ILS Training Field and well to the east of the outer marker (the NDB, "0"). The airplane heading does not matter for this experiment. The Glide-Slope Indicator should show the glide-slope path to be above the airplane. Check this on both the HSI and the VOR (H key). Now move the plane westward toward the ILS Training Field and observe the Glide-Slope Indicator. The glide-slope marker/needle will move down as the plane approaches the ILS Training Field. You might explore further to see if you can find any false glide slopes.

6. INSTRUMENT FLYING

We warn all AIRSIM-3 users that the discussion in this chapter is intended only to indicate how AIRSIM-3 operates. It is necessary to receive instruction from qualified flight instructors regarding the proper use of actual aircraft instrumentation and instrument-flight procedures before using them in real aircraft flight.

In this chapter we'll discuss how AIRSIM-3 can be used to provide instrument-flying practice. We can by no means cover the topic of instrument flying. There are books devoted entirely just to that subject, and we recommend the following as two books we have found helpful:

1. Richard Taylor, Instrument Flying, MacMillan, 2nd Edition.

2. William K. Kershner, The Instrument Flight Manual, Third Edition (The Instrument Rating), Iowa State University Press.

The Taylor book should be obtainable through any bookstore. It includes some discussion of the HSI. The Kershner book may be available at your local airport. It was at ours. We also recommend the following charts or their equivalents:

1. Los Angeles and San Francisco Sectional Aeronautical Charts, U.S. Dept. of Commerce.

2. Instrument Approach Procedures, U.S. Dept. of Commerce.

We got our copies of the Sectional Aeronautical Charts at our local airport. Our local FAA office provided us a with copy of the Instrument Approach Procedures for the U.S. Southwest. We recommend highly that you get some appropriate charts and approach procedures. They will add immeasurably to your enjoyment and rewards from using AIRSIM-3.

We have included as Figure 2, the center spread in the manual, a simplified chart of the region covered by the AIRSIM-3 scenery. This chart shows the airports and the navigational aids included in the AIRSIM-3 data base. We have assumed the magnetic variation to be 16 degrees throughout the AIRSIM-3 scenery. This is an approximation, the actual magnetic variation being near 15 degrees in the southern part of California and 17 degrees near San Francisco.

Approach Charts

We have provided 8 approach charts in Figures 3 through 10. Seven of these approach charts, Figures 4 through 10, are simplifications of actual approach charts, and are to be used only with AIRSIM-3. They must not be used for navigational purposes with real aircraft. Figure 3 is an approach chart for the Home scene; it is of course a ficticious scene. Study this chart. Find the Airsim VOR (114.9). Note the radials from this VOR marked as R-72 (72-degree radial), R-108, R-125, and R-180. Notice also the 20 DME Arc, an arc 20 NM from the Airsim VOR.

We recommend that you initially practice instrument approaches without any wind. Later you should try them with a wind, especially if a wind is to be expected.

We shall illustrate the use of the approach charts with an ILS approach to the ILS Training Field using the approach chart in Figure 3. We shall approach from the north along the 20 NM DME Arc. Make sure that Home-Scene localizer (111.1), LOM (388), and Airsim VOR (114.9) have been selected (N key if necessary). We'll use the CTRL-T command and the Move-with-Joystick mode (M-key mode) to position the airplane once we are in the air.

Take off and get the airplane on a heading of 170 degrees. Set the OBS on the secondary VOR display (114.9) to 72 degrees corresponding to the R-72 radial. Use CTRL-T and the M-key mode to position the airplane at 3500 ft altitude at the intersection of the R-72 radial and the 20 DME Arc (VOR-display needle centered and DME = 20). You are now at the Initial Approach Fix (IAF) on the 20 DME Arc. The arc is marked 3500 NoPT. That means that the arc is to be flown at an altitude of 3500 ft, and that no procedure turn is to be made. (A procedure turn involves a 180 degree change in direction.)

We want to fly along the 20 DME Arc (keep the DME reading near 20 NM) at 3500 ft altitude until we reach the R-108 radial from the VOR. We use a throttle setting just below 40% with an airspeed of approximately 120 knots. To fly the 20 DME Arc, break the arc up into a few straight-line segments rather than trying to setup a constant turn rate that will do the job. The turn rate would be too small to register on the turn-rate indicator. Upon reaching the R-108 radial, we are to make a right turn to a course of 270 degrees and maintain 3500 ft altitude until we intercept the glide slope, which should happen near the intersection of the R-125 radial from the VOR and the 270 degree approach course for the ILS. The Course-Deviation Bar/Needle will be centered on the HSI/VOR display when we are on this 270-degree approach course. Then we want to lower the flaps and fly down the glide slope along the 270-degree approach path to the ILS. The glide slope passes over the outer marker (LOM) at an altitude of 1087 ft. When our plane passes over the outer marker, the ADF needle should swing from pointing forward to pointing aft. We should also hear the 400 Hz outer-marker tone and see an X in the OM box. We should find ourselves in good shape for making a visual landing when we pass over the middle marker (MM). If not, we are then to abort the landing and execute a missed-approach procedure. This involves immediately applying full throttle and climbing to 800 ft. We can then ease off on the throttle and make a gradual climbing right turn to 2500 ft. altitude on a course of 0 degrees (due north). We are to fly along the R-180 radial of the Airsim VOR until we pass the VOR. We are then to fly a holding pattern, a counter-clockwise race-track pattern which has one corner over the Airsim VOR. There, in real life, we would await instructions from the aircraft controller for making another approach. In this case, no such instructions will come, of course, unless you give them to yourself.

tion. To tell when you're past the R-108 radial at the lower end of the 20-DME Arc, you set the OBS of the VOR display to 108 (degrees) immediately after entering the 20-DME Arc at the R-72 radial. The Course-Deviation Needle of the VOR display will then be at the far right during most of the arc, and will swing past center as you cross the R-108 radial. You will then reset the OBS to 125 in preparation for crossing the R-125 radial. Again, you'll know you're crossing the radial when the Course-Deviation Needle swings past center. Then you should reset the OBS to 180 in preparation for the possibility (likely if you are a beginner) that you will have to execute a missed-approach procedure.

As you fly down the ILS glide slope on the final approach, you will try to keep the Course-Deviation Needle/Bar of the HSI/VOR display centered. You will also make gradual adjustments to the elevator and throttle to stay near the glide slope. If you are a beginner, you will almost certainly overcontrol the airplane and deviate widely first to one side and then to the other side of the desired course. In all fairness, we must admit that AIRSIM-3 is more difficult to control then most real airplanes.

If you select the IFR mode when you start the program, you'll not be able to see any scenery when your altitude exceeds 512 ft. That is real instrument flying. Alternatively, you can press the I key to disable the scenery display at any time if you are not in the IFR mode.

What Next

Once you've gotten proficient with ILS approaches at Home, you can try it at the other airports. Santa Barbara RWY 7 and Los Angeles Runway RWY 6R are both different than the others in that they do not have outer markers. These two approaches are over the Pacific Ocean and use intersections with VOR radials as substitutes for outer markers. For example, the Los Angeles RWY 6R approach uses GUPPI intersection (GUPPI INT), defined as the intersection of the localizer 69-degree course with the R-205 radial from the Santa Monica VOR (110.8), as a substitute for an outer marker.

Customized Approach Situations (Your-Approach Mode)

AIRSIM-3 gives you a facility for setting up your own customized approach situations. This feature is activated by pressing the CTRL-Y key (Y for Your Approach). The procedure is very simple. AIRSIM-3 includes an example built into the program. This example is RWY 6 at Bradley International Airport, Windsor Locks, Connecticut. You can set up similar situations for any runway in the world. You can specify the wind conditions, runway location, and an ILS with one auxiliary VOR, or no ILS but two VOR's and one NDB. You have considerable flexibility. For example, you can specify only the wind conditions, or you can specify only the locations of the navigational aids while still retaining the AIRSIM-3 scene. However, if you specify a runway location, you will not be able to have California coastal scenery at the same time.

tion using the Your-Approach mode (CTRL-Y key). AIRSIM-3 cannot check to determine the physical validity of the situation you set up. Remember the computer saying, "Garbage in, garbage out" (GIGO)! You could be in serious trouble if, for example, you set up AIRSIM-3 to practice an instrument approach you actually plan to fly later and the situation you set up on AIRSIM-3 turns out to be significantly different from the actual one. The Your-Approach mode (CTRL-Y key) of AIRSIM-3 is very powerful, but like everything powerful, it thus has the capability of being correspondingly dangerous. Furthermore, while we have made every effort possible to insure that AIRSIM-3 functions properly, we cannot guarantee that the Your-Approach mode of AIRSIM-3 will set up landing approaches properly. You yourself must check the results to make certain that the approach situations set up using AIRSIM-3 do correspond properly with the appropriate real situation.

To proceed with the example, press the CTRL-Y key. You will be asked to specify the wind conditions. The default values are shown in parentheses, and you can simply press the RETURN key if you wish to accept the default value. For example, the default wind velocity is 0 knots and the default wind direction is 0 degrees (wind from the north). You'll then be asked if you want to specify a new runway. If you want to leave the scenery unchanged, accept the default value (No) by pressing the RETURN key. If you say Y, you'll be asked if you want an ILS approach. If you say Y, the computer will automatically set up the locations of the localizer and the outer marker for you. It will ask you for the outer marker distance (OM DISTANCE). The computer wants to know the distance from the end of the runway to the outer marker. This distance is shown on approach charts. It is 4.5 NM for Bradley Field.

The computer will ask you to specify the location of the end of the runway (the end you'll approach) in terms of latitude and longitude. You'll have to read this information off an aeronautical chart. Try to determine these locations to within 0.1 minute. Remember that 1 minute of latitude is 1 NM. Latitudes in the northern hemisphere are to be positive; those in the southern hemisphere are to be negative. Longitudes west of the Greenwich meridian are to be positive; those east of the Greenwich meridian are to be negative. You'll be asked to specify the runway heading (magnetic) and the local magnetic variation (east is positive). Next you'll be asked to specify the Touch Down Zone Elevation (TDZE). This is the altitude of the runway in feet. When you land, you'll have to remember that the ground is at the TDZE, not at zero, as it is at our ficticious and friendly Home!

If you specified an ILS, you will next be asked to specify the position (latitude and longitude) for the VOR you wish to use. If you specified a runway without an ILS, you'll be asked to specify the locations (latitude and longitude) for two VOR's and one NDB. You also will be asked to specify the frequency for all of the navigational aids. These frequencies are not actually used by AIRSIM-3 other than for displaying them on the appropriate instruments for identification purposes. Identification is important for avoiding navigational errors.

(shown in parentheses) if you respond to a request for input by pressing the RETURN key. Make sure the default value is appropriate before accepting it.

As a final example, assume you wish to fly along the California coast using the AIRSIM-3 scenery, but that you wish to use a VOR or NDB which is not included in Table 1, the AIRSIM-3 data base for navigational aids. You wish also to specify the wind conditions. You can use the Your-Approach mode. When asked "NEW RUNWAY? (N)", press the RETURN key for "no". The scenery you are using will be left intact. You can then enter the locations for the navigational aids. You are thus not limited to only the navigational aids in the AIRSIM-3 data base. The N-key command is merely a convenient way to use certain navigational aids.

presented several examples [illegible]
You will probably need help. You can get help from books on [illegible] and a your local airport. If all else fails, contact us. We'll be glad to try to help.

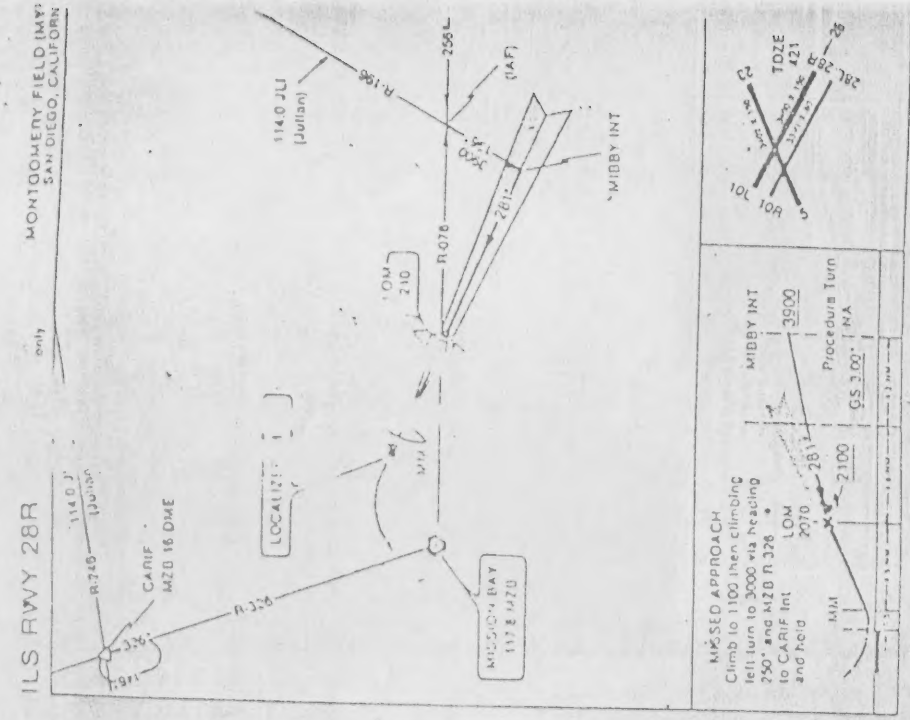

Figure 4. Montgomery Field, San Diego, RWY 28R.

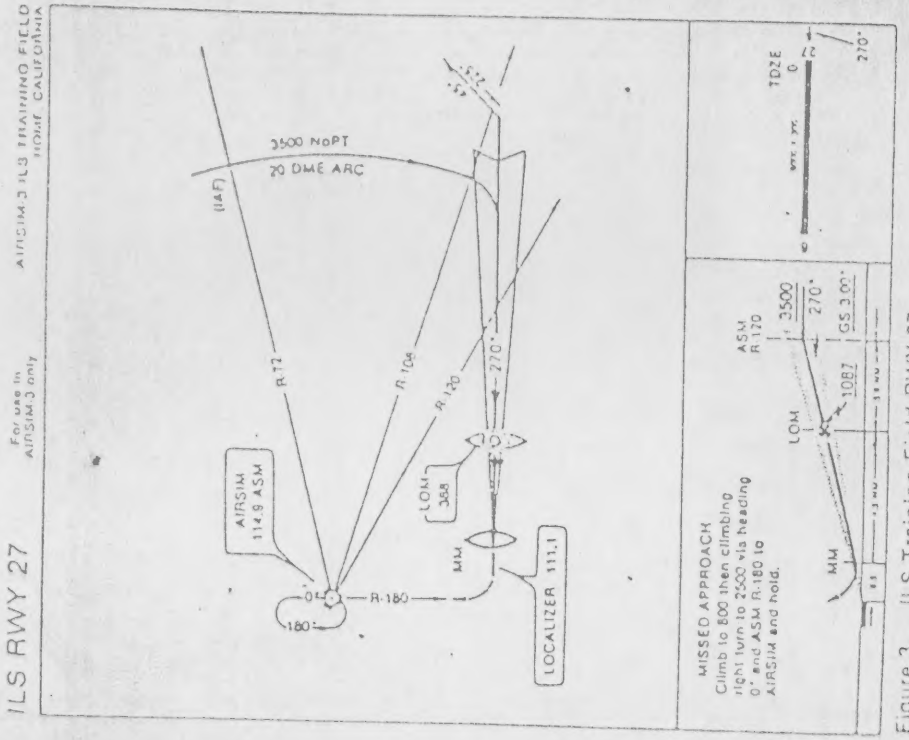

Figure 3. ILS Training Field RWY 27.

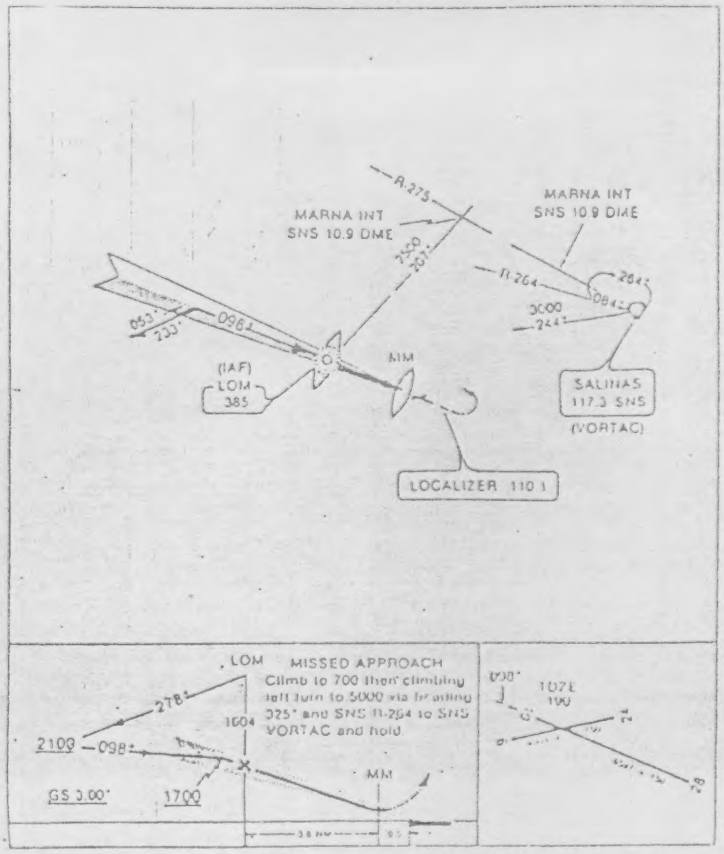

Figure 9. Monterey Municipal Airport RWY 10.

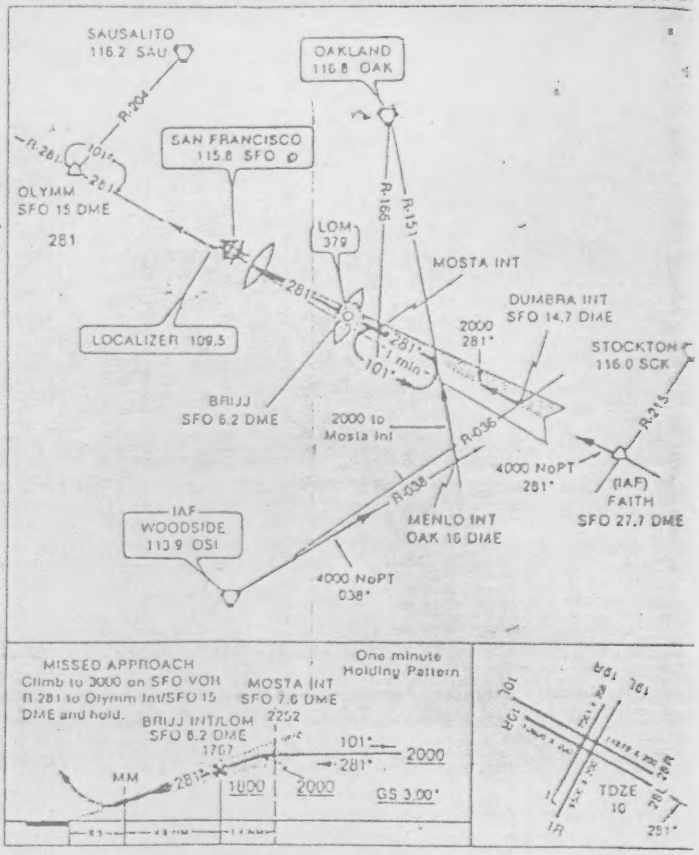

Figure 10. San Francisco International Airport RWY 28L.

SUMMARY OF COMMANDS

Paddle 0 — Aileron/rudder, clockwise right.
Paddle 1 — Elevator, counterclockwise up.
/ key — Toggle throttle.
— key — Increase throttle gradually.
= key — Decrease throttle gradually.
. key — Brake.
A key — Toggle aileron sensitivity.
E key — Toggle elevator sensitivity.
F key — Toggle flaps.
H key — Toggle HSI/VOR display.
I key — Instruments only.
J key — Look left.
K key — Look right.
L key — Level the wings.
M key — Move-with-Joystick mode.
N key — Navigational-Aid adjustments.
P key — Initialize radar scale.
R key — Radar.
S key — Scenery.
X key — Toggle aileron-rudder coupling.
+ key — Increase radar scale gradually.
- key — Decrease radar scale gradually.
@ key — Initialize radar scale.
CTRL-C — Continue the simulation.
CTRL-I — Initialize the simulation.
CTRL-T — Transport the airplane.
CTRL-Y — Your-Approach mode.
ESC — Pause.
ESC 0-9, Q-O Select Scenes.

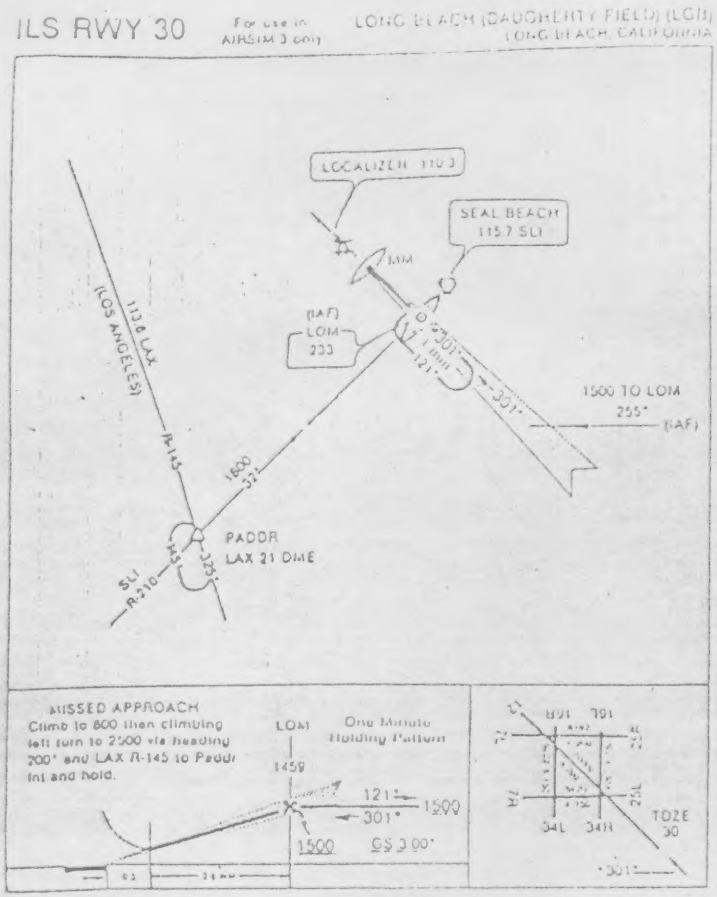

Figure 5. Daugherty Field, Long Beach, RWY 30.

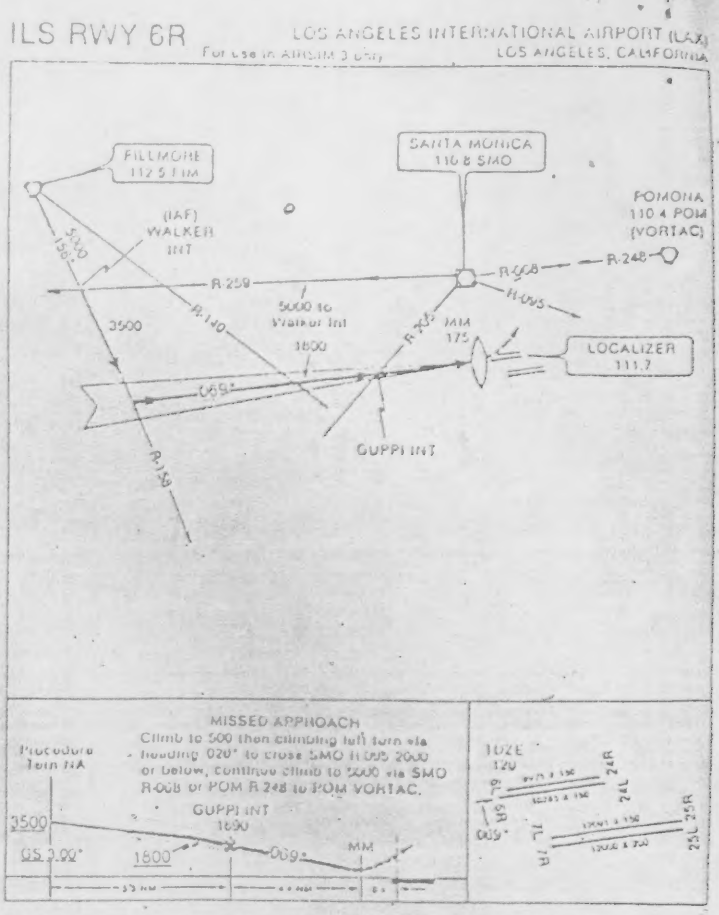

Figure 6. Los Angeles International Airport RWY 6R.

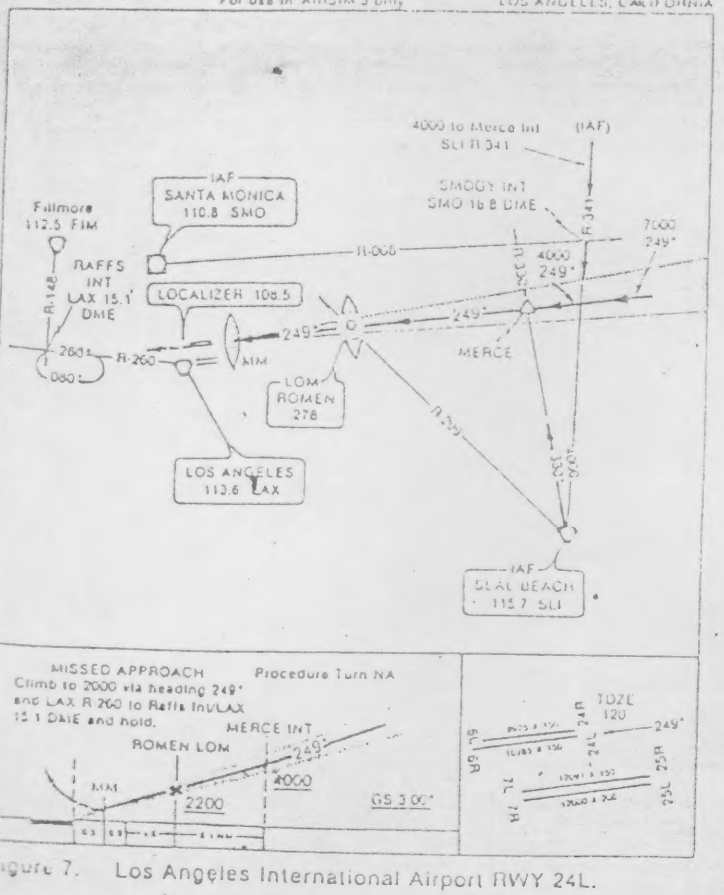

Figure 7. Los Angeles International Airport RWY 24L.

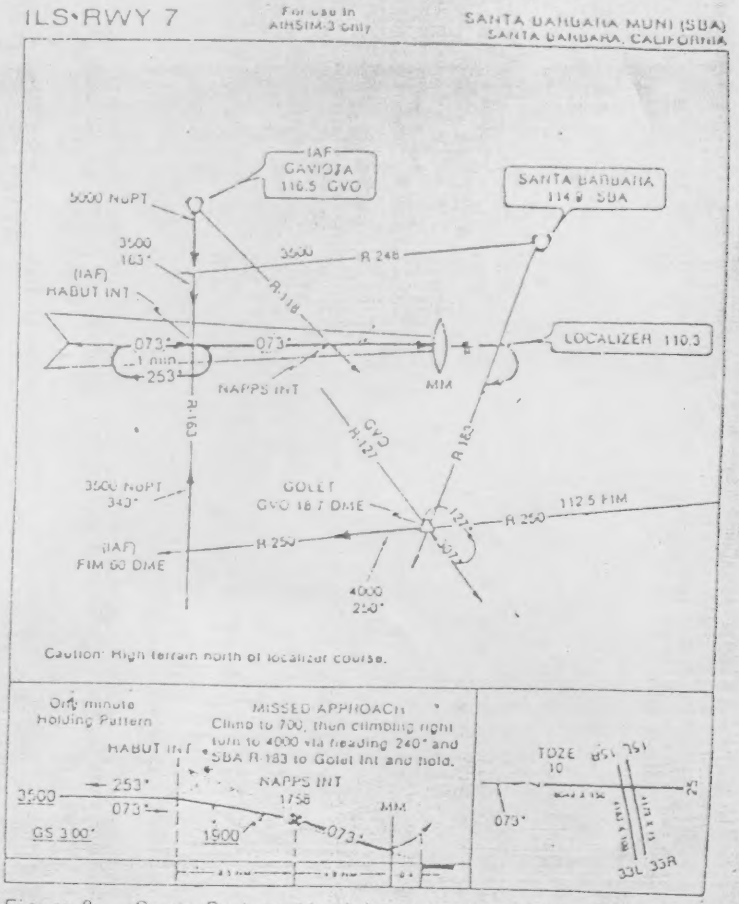

Figure 8. Santa Barbara Municipal Airport RWY 7.